JULY, 1954

JUL -8 1954

PIPE LINE INDUSTRY

Gulf Publishing Company

CONSTRUCTION • OPERATIONS • MAINTENANCE

A New Magazine . . .

Construction Boom Forecast . .

Where Will Oil, Gas Come From?

This is the first issue of a new and different monthly periodical dedicated to complete coverage of a great and growing industry. See Page 4.

Pipe line capacity must be expanded greatly by 1975. A survey of industry leaders mirrors a bright future. Page 70

Five prominent geologists have answered this question in a symposium that starts on Page 73.

See Page 3 for additional contents and a Quick Review of this issue

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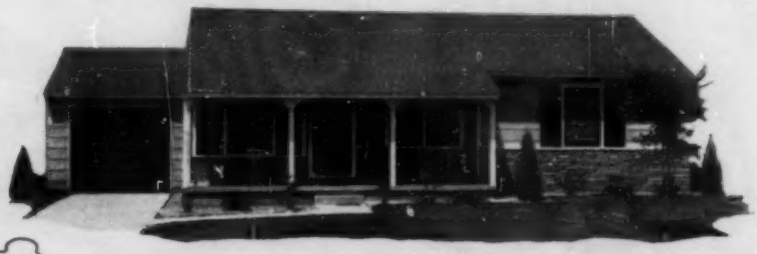

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PIPE LINE INDUSTRY

CONTENTS and Quick Review

July, 1954 Vol. I, No. 1

To help you put first things first, scan these time-saving digests, checking ☑ those you want to read first.

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Huge Pipe Line Building Program Ahead of U. S.

☐ A bright future lies ahead of the U. S. pipe line industry. Population is going places by 1975 and the pipe line industry is going with it. Larger oil and gas consumption will necessitate expanded pipe line capacity to move sufficient production. Consequently, much new pipe line construction will be required.

By Warren L. Baker.....Page 70

Where Will Oil and Gas Come From?

☐ Can sufficient oil and gas be found to supply the growing U. S. population? What areas will furnish the enlarged quantities needed? Five prominent geologists think much additional new oil and gas can be found. They were asked to participate in a symposium on the subject.

Page 73

When to Replace a Pump?

☐ Check the hidden costs of operating an old pump . . . power depreciation and repair costs. These may run higher than the cost of a modern replacement. Here's an article and chart that show you how to do it.

By C. E. Cromwell.....Page 81

World's Longest Sea-Loading Line

☐ Pipeliners had to battle eight-foot waves, strong currents, undersea boulders and black magic to lay what is believed to be the world's longest sea-loading line. The 12-inch line was laid off Africa's Gold Coast. This article tells how.

By Donald M. Taylor.....Page 84

Gate Valve Tester Solving Problems

☐ Employes of Service Pipe Line Company have made a gate valve tester that's saving money and solving some problems. With it they can test 4- to 12-inch valves in the warehouse to prevent faulty ones from showing up on the job.

By Carl I. Huss.....Page 88

Main Line Compressor Stations

☐ A panel composed of compressor department heads of three leading gas transmission companies discusses reciprocating, steam turbine, electric, and gas-fired turbine compressor stations.

Page 90

Determining Flowing Temperatures in Gas Lines

☐ Here's a new formula for calculating the temperature of pipe lines on the discharge of compressor stations. This temperature gradient is beginning to receive careful scrutiny of design engineers with the idea of eliminating discharge gas cooling equipment which only protects the coating from plastic flow.

By Charles E. Schorre.....Page 94

1220-Foot Span Raised in One Hour

☐ Here's a new-type aerial span that may revolutionize river crossings. The span can be made on shore, floated across the water, and hoisted into place in one hour. Towers on either side serve as gin poles.

By Donald M. Taylor.....Page 98

What About Internal Plastic Pipe Coating?

☐ This process may solve many problems in the pipe line industry. It may mean the end of rouge troubles in products lines . . . internal corrosion in sour crude lines . . . dust and mill scale in gas lines. Improved friction factor could mean greater throughput.

By Frank E. Hangs.....Page 106

What's Ahead in Cathodic Protection?

☐ Steel anodes . . . calcium anodes . . . solar or atomic batteries? Here are some eyebrow-raising speculations on future developments and trends in this field.

By Marshall E. Parker.....Page 108

The Employe Looks at the Boss

☐ Are you a good employer? We asked a cross-section of superintendents, engineers, foremen and miscellaneous workers to name six qualifications of a good boss. They replied in substance: "He doesn't need six qualifications. Just one."

By Al Reese.....Page 117

Measurements and Controls in Pipe Line Operations

☐ Look for more and more pump stations to be operated by remote controls. Instruments are improving. The trend is to provide adequate controls with emphasis on simplicity.

By A. H. Newberg and E. C. Schuster.....Page 122

Public Relations Is Everybody's Business

☐ El Paso Natural Gas Company explains company operations to its employes in down-to-earth language. The employes tell their neighbors about it. And everybody benefits in the long run. Plus the Map of the Month.

By Marshall Willis.....Page 132

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Pipe Line Industry

. . . An Expanded Service

With this, its initial issue, PIPE LINE INDUSTRY offers itself as a service to the worldwide pipe line business.

As a new magazine, devoted exclusively to the business of designing, constructing, operating and maintaining oil, gas and product pipe lines, it is the logical outgrowth of plans which have been maturing in the minds of management and editors of WORLD OIL for a long time. With this issue what had grown to be one of the major sections in WORLD OIL, the Pipe Line Section, has become a separate magazine for pipe line men and contractors only. Unless a man has an active connection with the pipe line business, he will be disappointed if he tries to read it!

But if you are a pipeliner, we believe you will like it. It is edited for you as a pipeliner. Its aim is to help the growing pipe line business and the men who make that industry. Its staff is composed of experienced men, some of whom have been writing about the pipe line business for nearly 40 years. Some have had active service with pipe line companies. Most of the editorial staff are engineers, but the bulk of the editorial content, as has been the case in the very popular Pipe Line Section of WORLD OIL, will be written by men in the pipe line business itself.

The main job of the staff is not merely to write, but to maintain contact with pipeliners, keep up with the times, and get competent men from within the industry to write on matters of interest to the pipe line men who read our magazine.

•

In 1947, when *The Oil Weekly* changed its name to WORLD OIL and became a monthly publication, plans had been drawn to begin publication of a monthly pipe line magazine, but instead it was decided at the last moment to include a Pipe Line Section in WORLD OIL. Later the number of pages of pipe line reading matter was increased substantially. Pipe line circulation showed a steady growth.

In 1950, Donald M. Taylor, an engineer with several years' experience in the pipe line business, was employed as Pipe Line Editor of WORLD OIL, but before he assumed his duties as an editor, he was given a preliminary assignment.

He was handed a list containing 100 names of pipe line executives, contractors, engineers of varying grades and types, superintendents, purchasing agents, foremen and others. It was as well chosen a cross-section of the pipe line and contracting business as the management of WORLD OIL could select, and geographically it meant a lot of travel for the new editor, as he soon learned.

"Before you begin writing and choosing pipe line articles for your section of WORLD OIL," he was told, "you must personally visit every man on this list, find out what he would like to see published in WORLD OIL's Pipe Line Section. Also ask him to eliminate from the survey sheet you will show him the kind of articles he isn't interested in. We want *his* ideas as to what *he* thinks the best pipe line paper should contain."

Don Taylor left with a complete "sample book" of articles of various types, a set of special printed forms covering three solid pages and the determination to find out what pipeliners wanted to read.

Two months later Don completed the job. The men he had seen were courteous, most of them very helpful. He returned to his office two months later filled with information and enthusiasm for his new job. The ideas gained were put to work.

•

Circulation began climbing. Pipe line reading pages were added. Then an idea was adopted of adding 24 editorial pages of purely pipe line reading matter (of interest only to pipe line men) and of including it only in copies of WORLD OIL going to pipeliners, because non-pipe liners had no use for it. The edition containing this matter was called the "Pipe Line Edition."

Circulation continued to climb at a phenomenal rate. A mail check was made with those who were seen on Don's first fact finding trip and the verdict was, "You're on the beam." Then at the beginning of 1954, advertising was accepted in the special Pipe Line Edition so that manufacturers and service companies, wishing to advertise their products or services only to pipeliners would not have to pay for more than 20,000 non-pipe line subscribers. Getting closer to a separate paper!

And now PIPE LINE INDUSTRY is born. Though it is the first issue under its new name it really isn't new to most of you who read this. The editorial features and policies which were popular in the Pipe Line Section of WORLD OIL, you will find, are being carried out and expanded.

But we have some new ideas, too. You will find some of them in this issue.

However, on Page 6 we present you the men who will help in the writing and editing of PIPE LINE INDUSTRY. We repeat, it is for pipe line men only. We hope you like it. We expect to make good on our promise that it will help the pipe line business and the men in it.

We crave your regular readership, your friendship, your good word.

Sincerely,

Ray L. Dudley

President, GULF PUBLISHING COMPANY
Publisher, PIPE LINE INDUSTRY

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...at the pressure-capacity range available in the

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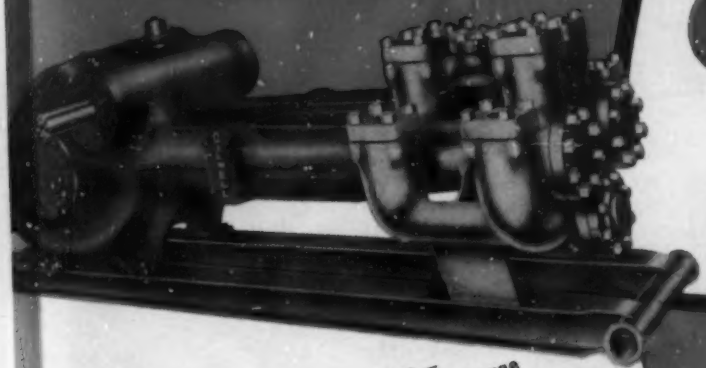

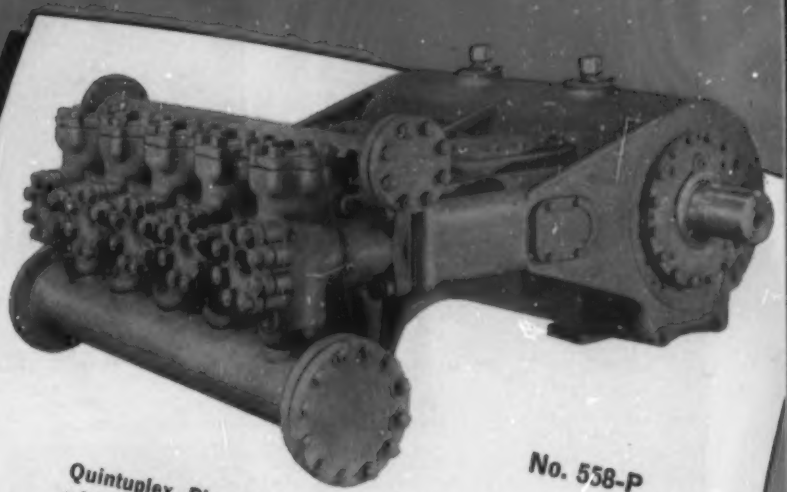

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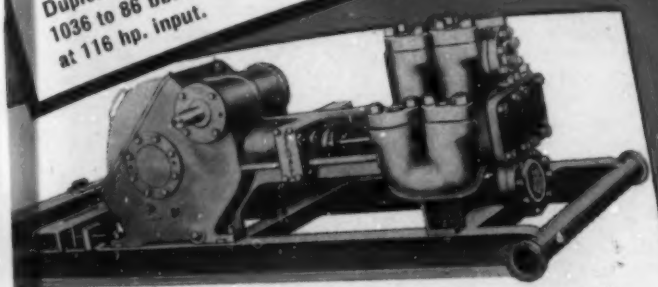

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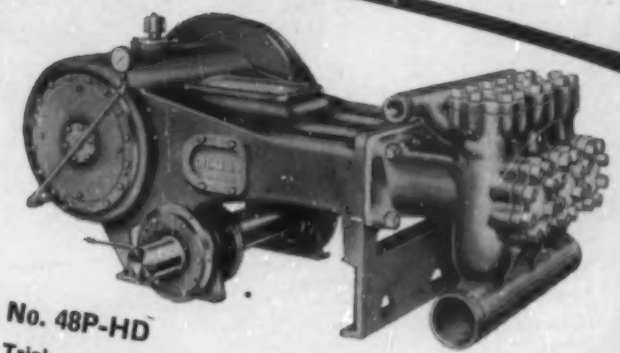

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WORLD OIL and THE COMPOSITE CATALOG for the drilling-producing-pipe line industry.

PETROLEUM REFINER and THE REFINERY CATALOG for the refining-natural gasoline-petrochemical industry.

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A. L. BURNS, Vice President, General Manager

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RAY L. DUDLEY . . . publisher, pioneered specialized oil industry publications.

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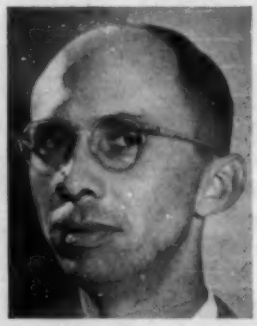
AL REESE . . . managing editor, 20 years as newspaper and magazine editor.



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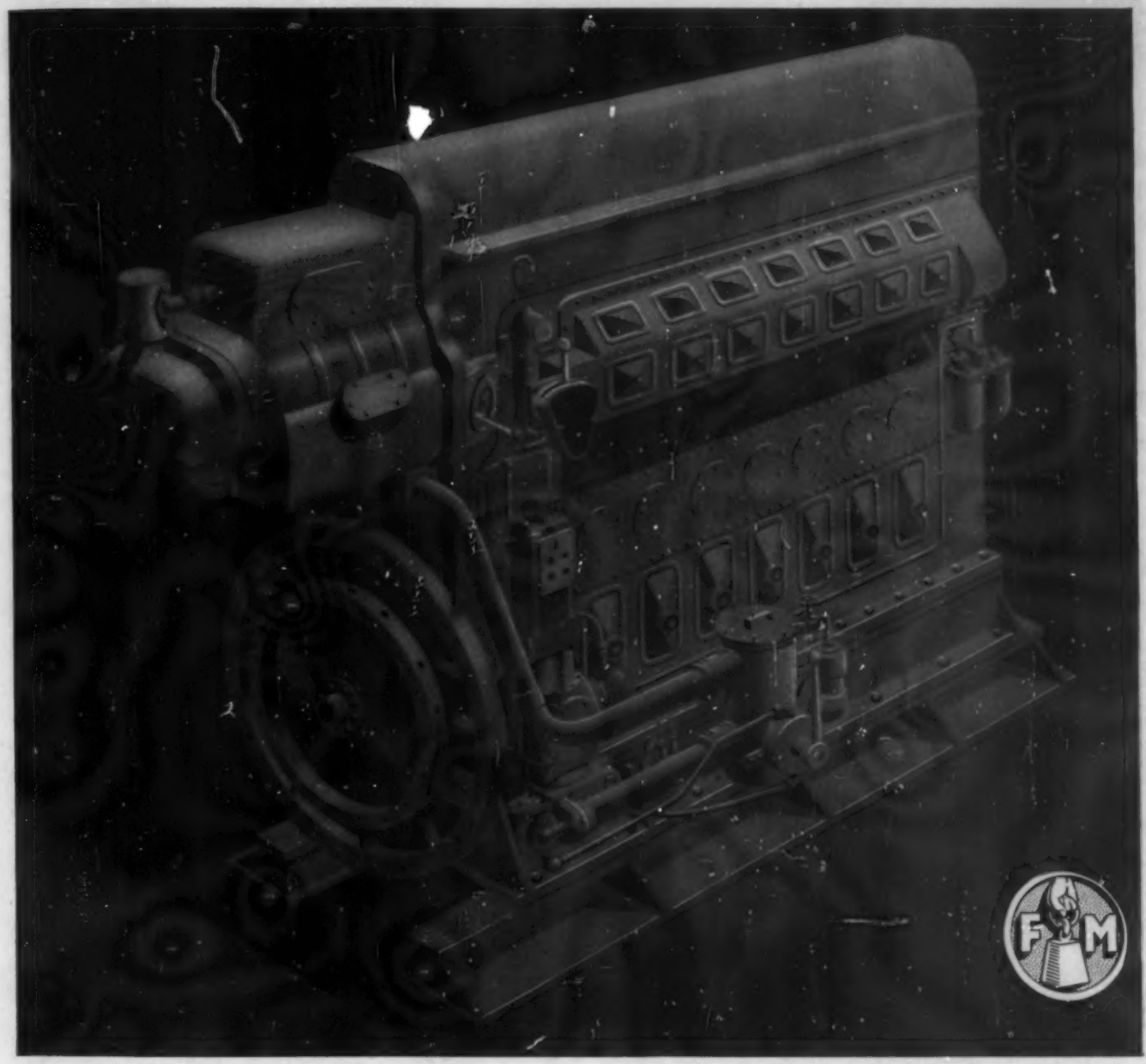
ANTHONY GIBBON . . . Mid-Continent editor, 12 years with WORLD OIL.

WALLACE FITZGERALD . . . production, layout, 14 years on newspapers, magazines.

MARY STUART WARREN . . . editorial assistant, former newspaperwoman.



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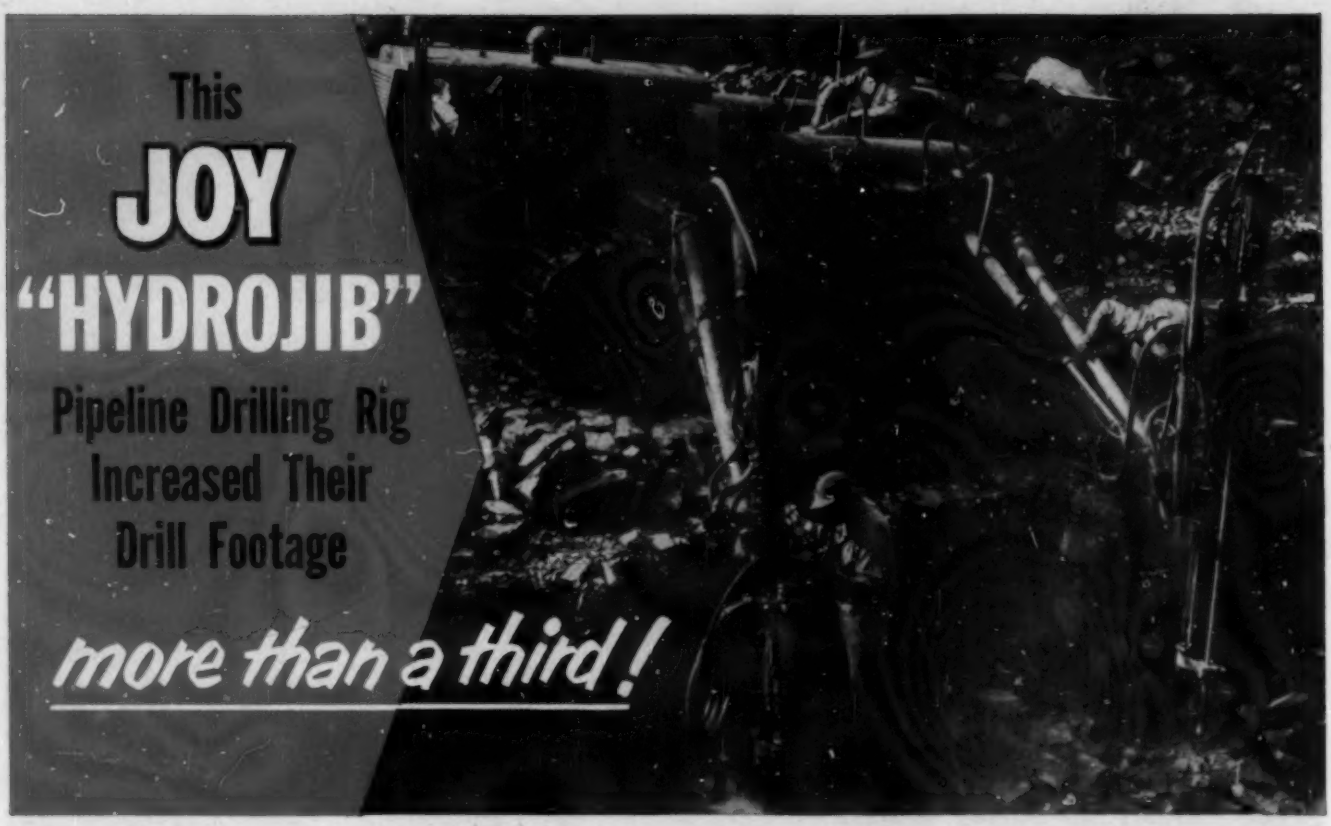

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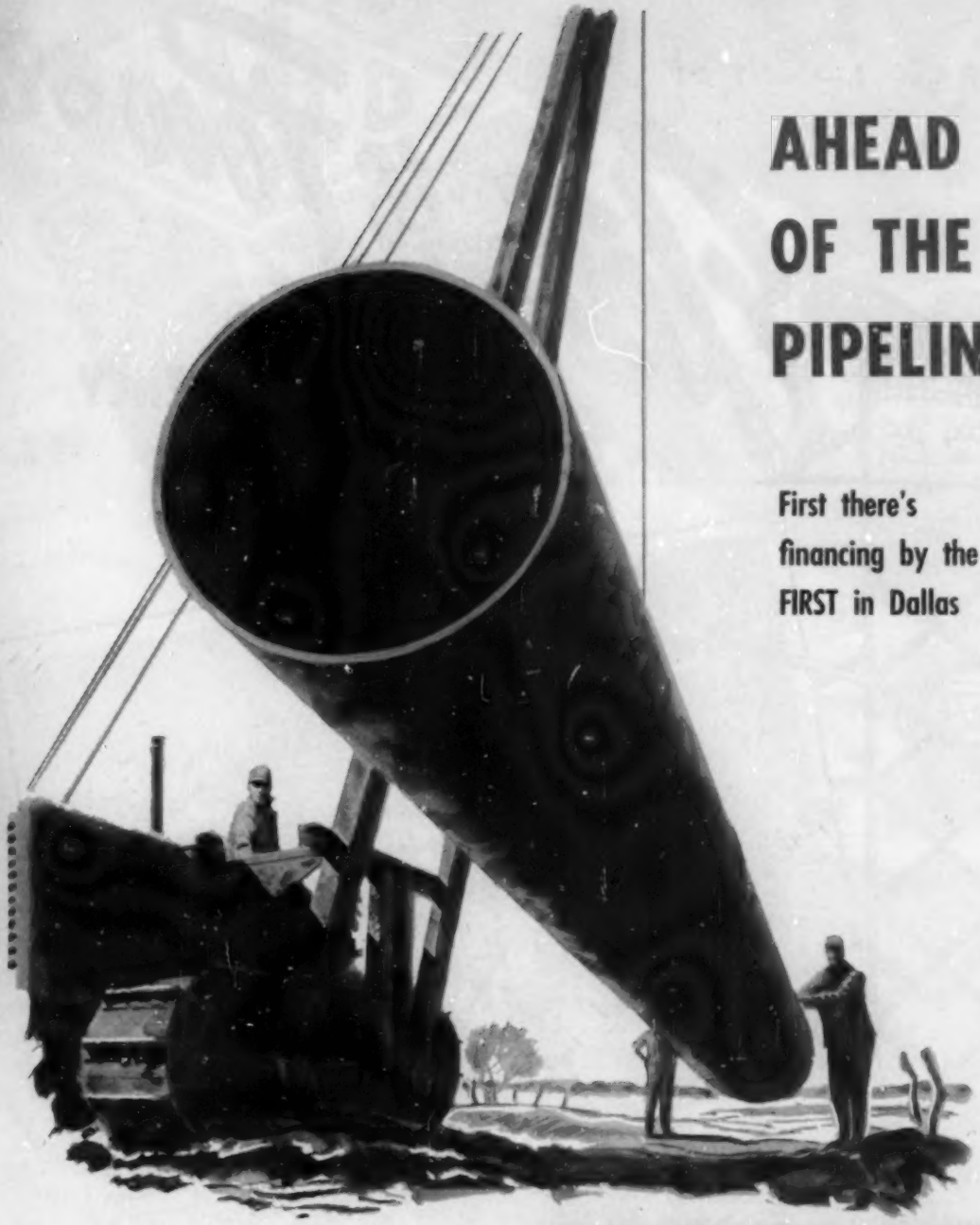

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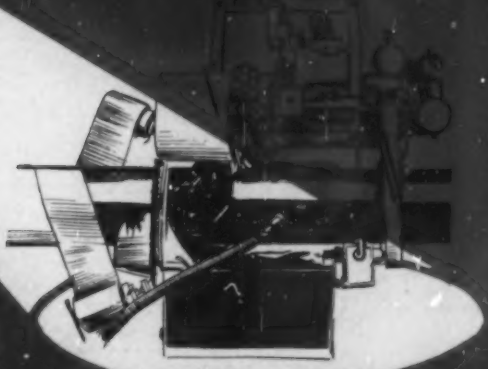

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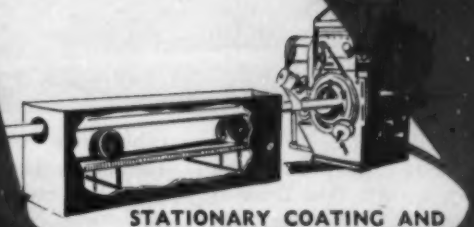

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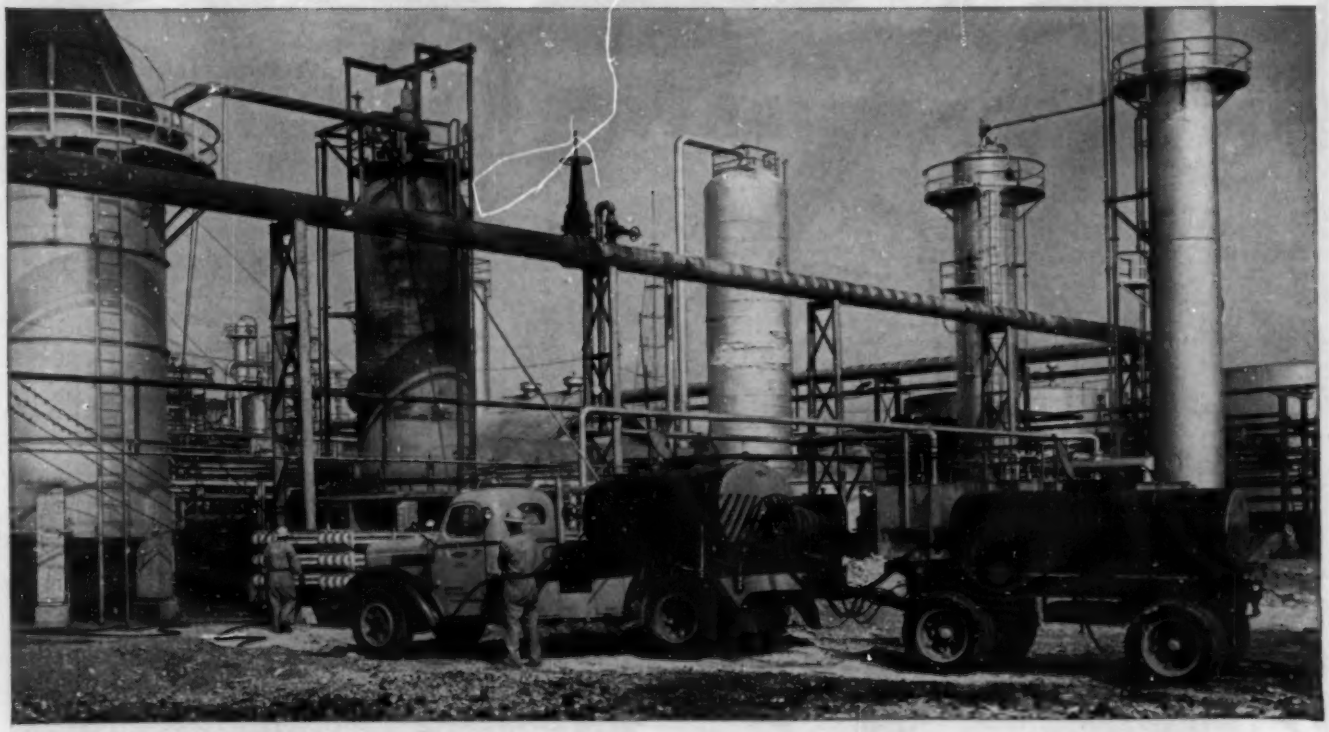

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Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping System • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED • TULSA 1, OKLAHOMA

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

Results never vary...

. . . Every Drum meets WRITTEN SPECIFICATIONS.

UNVARYING pipeline enamel quality isn't an accident. It's the direct result of laying down written specifications and holding enamel manufacture to close tolerance within those "specs."

Pitt Chem Modified Pipeline Enamel is made to written specifications that are available to any customer. We invite you to pick out any drum of Pitt Chem Modified at random on your line and compare the actual product to our written specifications. Draw your own conclusions. After comparing, we think you'll agree that coal-to-enamel quality control actually does produce a true-to-specification enamel which will do a better job on your line—*in application and in service.* Write for *Pitt Chem* Modified Enamel Specifications today!

- Standard Grade Tar Base Enamel
- Modified Grade Tar Base Enamel
- Plasticized Grade Tar Base Enamel
- Cold Applied Tar Base Coatings

PROTECTIVE COATINGS DIVISION

PITTSBURGH COKE & CHEMICAL CO.

Grant Building • Pittsburgh 19, Pa.

W&D 4907

COAL CHEMICALS • AGRICULTURAL CHEMICALS • FINE CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

Let us help you in planning ahead

One of the most important ways in which we can serve our customers is to assist them in planning for sound growth. Based on past experience and the interpretation of today's business trends, this sound, practical advice is one of the important services offered by The National Bank of Commerce, where every modern banking facility is available to serve its industrial depositors.

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THE NATIONAL BANK OF COMMERCE

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Gulf Building, Houston, Texas "The Bank for All the People"

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Wherever weeds and grasses are a

FIRE HAZARD... *you need*

this reliable weed destroyer!

BORASCU®

WEED KILLER

Borascu gives you the safety of bare ground about any installation at any location—well sites, tank batteries, heater units, and buildings. And you get this freedom from fire-hazardous vegetation with lower cost than other methods! Some economy-minded production men figure the Borascu way has resulted in 80% savings!

Borascu is a granular, nonorganic, nonselective weed killer which affects *all* vegetation! Borascu does not break down in soil but remains active for long periods to keep vegetation from reappearing. Just a man and a pail is all you require for applications—no other equipment is necessary; there is nothing to mix and no water to haul. You won't know how easy it is to keep grounds bare of fire-hazardous weeds and grasses 'til you try Borascu!

WHEN BORASCU IS IN THE SOIL... WEEDS STAY OUT!

NOTHING TO MIX

NONPOISONOUS

NONCORROSIVE TO FERROUS METALS

MANUFACTURERS OF FAMOUS "20 MULE TEAM" PACKAGE PRODUCTS

PACIFIC COAST BORAX CO.

DIVISION OF BORAX CONSOLIDATED, LIMITED

630 SHATTO PLACE • LOS ANGELES, CALIFORNIA

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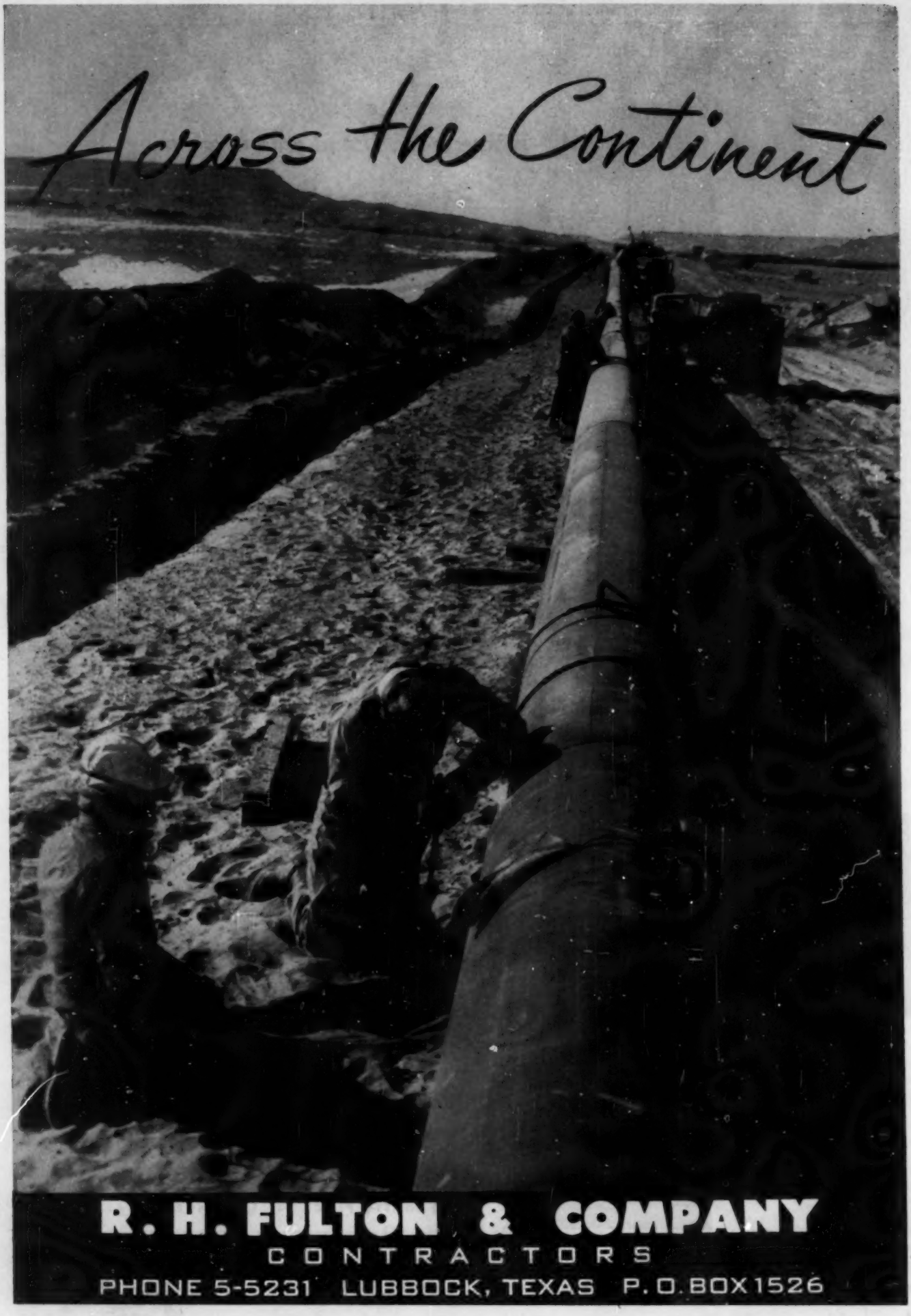
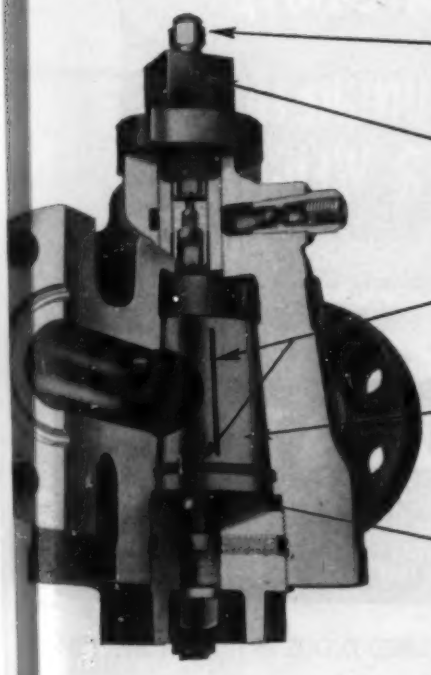

Across the Continent
R. H. FULTON & COMPANY
CONTRACTORS
PHONE 5-5231 LUBBOCK, TEXAS P. O. BOX 1526

ROCKWELL-Nordstrom Valves Do The Important Jobs

There's too much at stake in pipe line operations to risk a jammed valve or one that's spurting its own private gusher. That's why Rockwell-Nordstrom valves guard *vital* spots on most lines.

Rockwell-Nordstrom valves out-perform ordinary valves because all metal-to-metal surfaces glide on a pressurized lubricant film that eliminates friction and forms a positive seal against leakage. And the seat of the valve—never exposed to corrosive or erosive ravages of crude oils—rests on a powerfully resilient cushion of lubricant. Galled valves are eliminated; simply turning the lube screw hydraulically jacks the plug. With gear operated valves the one-quarter turn operation gives really exacting control. For example, an ordinary 16 in. valve requires approximately 140 turns of the wheel—a Rockwell-Nordstrom valve only 22 turns!

When positive control is a must in your operations, you *need* Rockwell-Nordstrom valves for dependability, less maintenance and longer service. Find out how they can do a better job for you at lower costs per year. Write for descriptive literature TODAY. Rockwell Manufacturing Company, Pittsburgh 8, Pa.


LUBE SCREW & GUN FITTING
Maintains Lubrication Pressure
STEM
One-Quarter Turn To Open Or Close Valve
LUBE CHANNELS
A Perfect Seal . . . Cut-Offs Prevent Leakage Into Line
TAPERED PLUG
Maximum Strength . . . Perfect Seating . . . Seat Never Exposed
LUBE CHAMBER
Jacks Up Plug For Easy Operation . . . Eliminates Stuck Valves

Canadian Valve Licensee: Peacock Brothers Limited

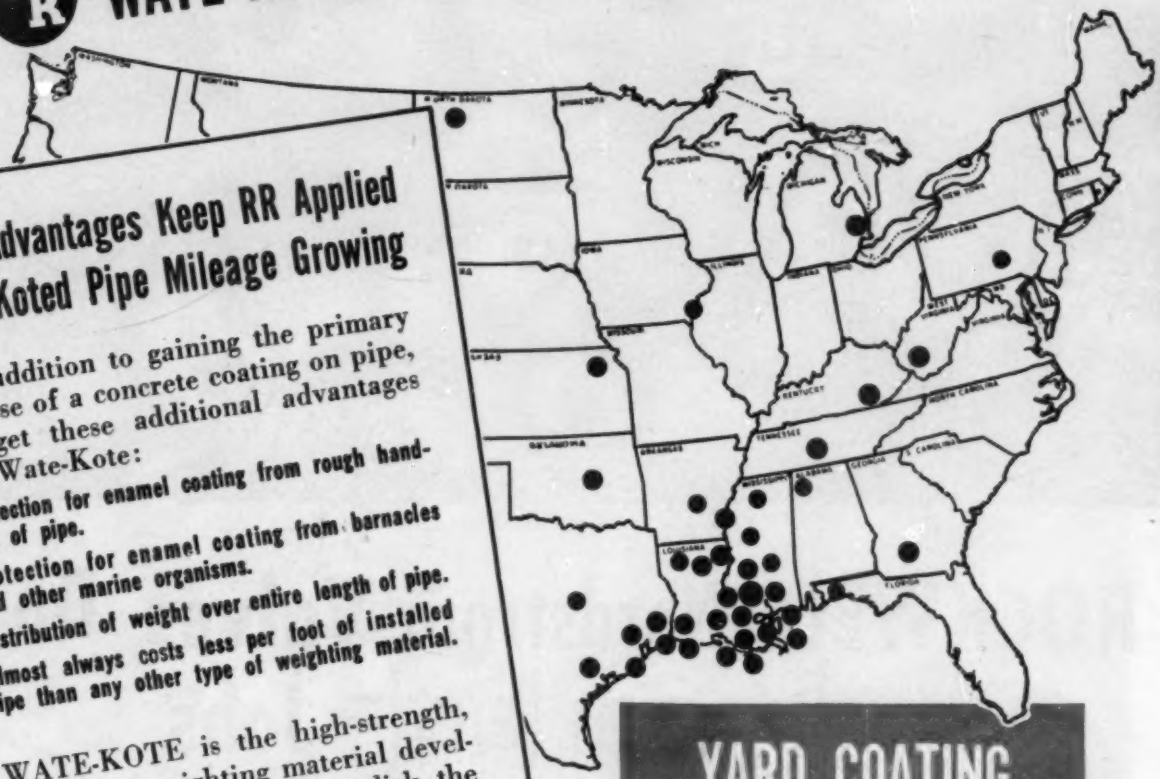
ROCKWELL-Nordstrom VALVES

Lubricant-Sealed for Positive Shut-Off

ROCKWELL

600 Miles...

RR WATE-KOTED PIPE—MORE IN PROCESS



Four Advantages Keep RR Applied Wate-Koted Pipe Mileage Growing

In addition to gaining the primary purpose of a concrete coating on pipe, you get these additional advantages with Wate-Kote:

1. Protection for enamel coating from rough handling of pipe.
2. Protection for enamel coating from barnacles and other marine organisms.
3. Distribution of weight over entire length of pipe.
4. Almost always costs less per foot of installed pipe than any other type of weighting material.

WATE-KOTE is the high-strength, high density weighting material developed by Rosson-Richards to lick the toughest weighting problems of laying pipe thru open water, rivers or marshy ground at minimum cost. WATE-KOTE is not only the heaviest weighting material of its type yet developed, but is tough enough to take a lot of punishment during laying operations.

YARD COATING and WRAPPING

WATE-KOTE CONCRETE RIVER WEIGHTS

• *Write today for folder telling method of applying Wate-Kote, pipe displacement and weights, buoyancy of pipeline submerged in fluid backfill, etc.*

RR ROSSON-RICHARDS

1076 M&M BUILDING • Phone CHarter 4661 • HOUSTON 2, TEXAS

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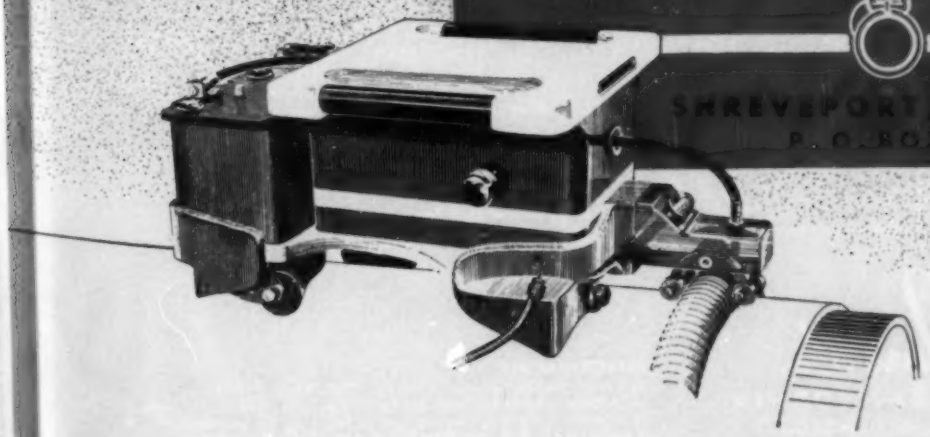
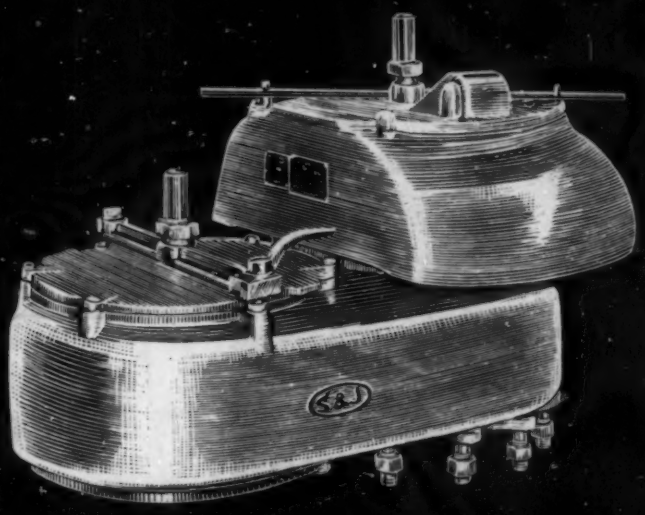


BETTER COATINGS CONSERVE STEEL

SAVE MORE VAPOR

WITH NEW S&J "TITE-SEAL" BREATHER VALVE

The new Shand & Jurs Breather Valve designed for Vapor Saving Storage Tanks and Systems will reduce to the absolute minimum vapor loss under "closed" conditions. Designated by S&J Fig. ST-7575, this breather valve incorporates a unique but very practical pallet design. It utilizes a pliable, reinforced, synthetic rubber coated diaphragm which provides the tightest possible seal for both pressure and vacuum relief valves through a novel balancing action. This assures minimum vapor loss at tank pressures and vacuums less than valve settings.



The diaphragm design provides a peeling action between the pallet and the seat which overcomes sticking or freezing to a very marked degree. When serious freezing hazards exist, a special diaphragm of Teflon coated fiberglass may be used. In laboratory and other tests, this has been found to require only ¼" of water beyond normal setting to break ice. The diaphragm also resists chemical action of additives and will retain its efficiency long past the time when a conventional poppet type breather valve would require relapping of the pallet and seat.

The S&J "TITE-SEAL" Breather Valve is available in 4", 6", 8", 10" and 12" sizes. For further information write the factory or nearest branch listed below for bulletin.

Pressure Pallet illustrated at the left. In operation, tank pressure is directed through a port to the chamber outside the seat but inside the pallet periphery and produces a slight ballooning to effect a perfectly tight joint at all pressures below that for which the pressure pallet of the breather valve is set to open.

Shand and Jurs Co.
BERKELEY 10, CALIFORNIA

NEW YORK
342 Madison Ave.

CHICAGO
10409 S. Western Ave.

HOUSTON
M & M Bldg.

TULSA
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LOS ANGELES
714 W. Olympic Blvd.

REPRESENTATIVES:
SEATTLE: Nebar Supply Company, 3000 Western Avenue
MONTREAL: Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W.
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CARACAS: Sinclair Spence, C.A., Edificio Galipan
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Whessoe, Ltd., Works: Darlington, County Durham

Just The Right Size

Small Enough to Give You Personal Service
Big Enough to Do The Job

Many River Construction pipeline jobs are repeat contracts from companies who have used us before. These companies have found the value of doing business with our organization; we have all the equipment, the personnel, *and* the experience necessary to complete jobs of any size on schedule. Every partner of our organization averages well over twenty years of pipeline experience — your job will benefit from this "know how" when you call on River.

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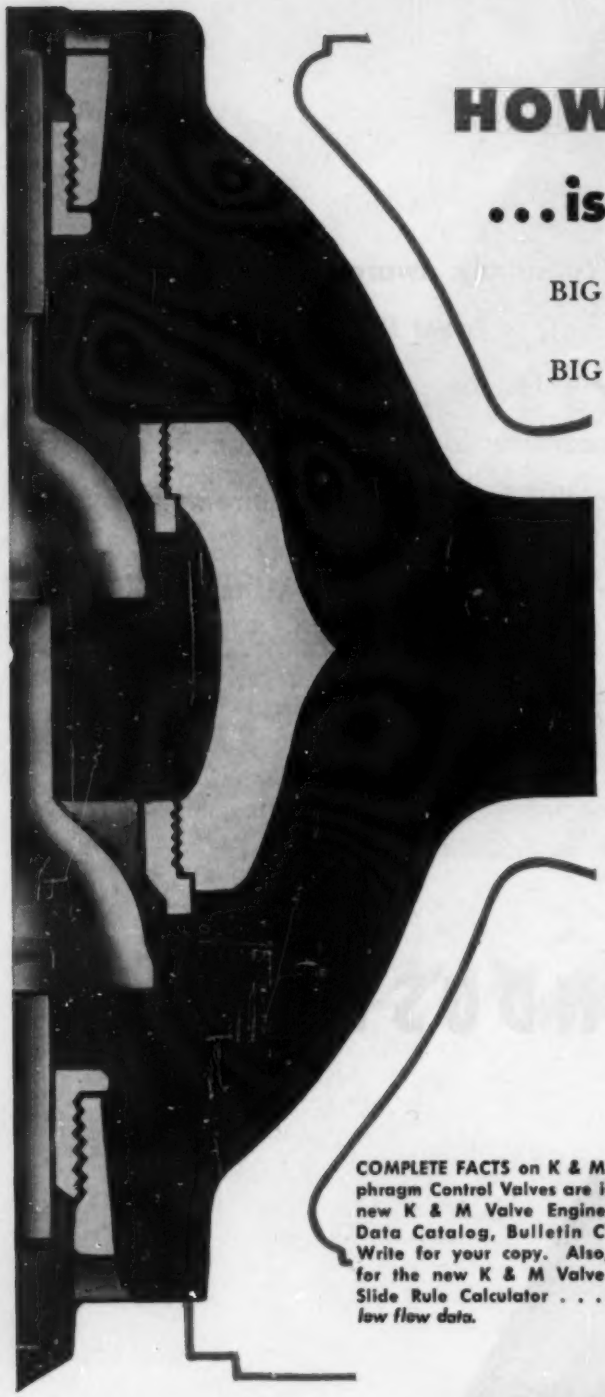
Continental representatives are constantly aware of the Pipe Line industry's many needs and how best to meet them. The services of these men in the field are augmented by a staff of experienced engineers familiar with Pipe Line construction and operation . . . men who take a practical approach in studying customer requirements.

This service — on a world-wide basis — supports the distribution of equipment and supplies unsurpassed in quality . . . through Continental's strategically located stores and offices.

. . . THE PIPE LINE INDUSTRY

REPRESENTATIVES IN ALL PRINCIPAL OIL FIELDS OF THE WORLD



HOW BIG

...is a K & M six-inch valve?

BIG enough to pass 500 gpm of cold water through the valve body at a constant drop of one pound pressure.

BIG enough to provide the largest flow coefficient available in a standard six-inch diaphragm control valve.

Body flow passages of all K & M valves, for example, actually average 140% of cross-sectional pipe area. There's more space for fluid to flow . . . smoothly, freely and without turbulence. Frequently a smaller nominal size K & M Valve provides sufficient capacity to satisfy requirements that formerly called for a larger, more expensive valve.

Inner valve open areas, on the other hand, average only 80% of cross-sectional pipe area. Therefore, flow restrictions occur principally across the inner valve . . . where the restriction is controllable throughout the entire range of valve stem travel.

This K & M design often permits lower initial costs . . . always contributes to more precise flow regulation through the K & M Inner Valve.

COMPLETE FACTS on K & M Diaphragm Control Valves are in the new K & M Valve Engineering Data Catalog, Bulletin CV53. Write for your copy. Also, ask for the new K & M Valve Size Slide Rule Calculator . . . with *low flow data.*

C_V COMPARISON TABLE

Valve Size	K & M	Valve B	Valve C
¾"	10.9	8.4	8
1"	17.3	14.9	12
1½"	39.1	33.2	28
2"	61	57	48
2½"	97.7	71.0	72
3"	150	116	100
4"	219	197	165
6"	500	364	360

Based on the maximum C_V at rated travel through the valve body. From manufacturers most recent slide rules or tables.

diaphragm control valves

K&M

Valve Makers Since 1879

KIELEY & MUELLER, INC.

64 Genung Street
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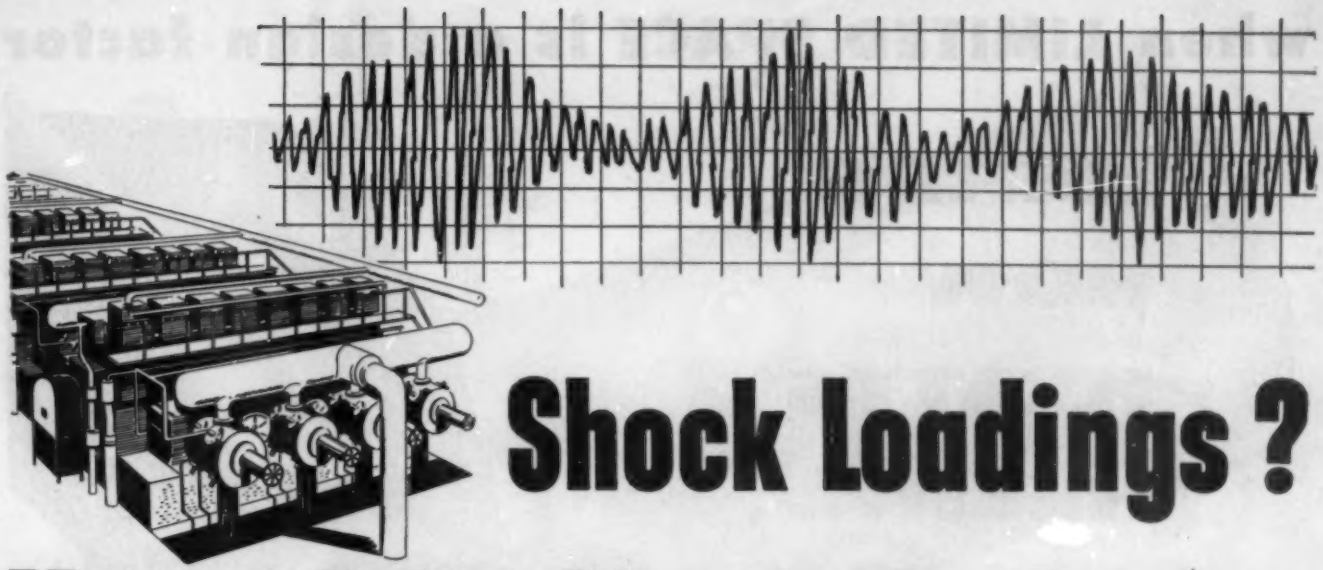


Shock Loadings?

Mayari R Gas Pipe is the Answer

If you're planning a compressor station, and you're looking for gas pipe that can handle the shock loadings, Mayari R Gas Pipe is the answer. Here's why:

1. High Ductility—Mayari R Gas Pipe is made of as-rolled steel plate, with 22 pct minimum elongation in two inches. This extreme ductility, in addition to Mayari R's great strength, makes it ideal for handling severe shock loadings.

2. High Yield Point—Mayari R is low-alloy, high-strength steel, with a yield point of 50,000 psi minimum.

3. High Endurance Limit—50,000 psi (polished bar specimen).

In addition, Mayari R Gas Pipe welds readily, and is highly resistant to atmospheric corrosion.

And for normal pipe-line service, you can count on welded carbon steel Bethlehem Oil and Gas Pipe. It's economical and reliable, made to specifications ASTM A-134 and API 5LX42.

In high-strength Mayari R or ordinary carbon steel, Bethlehem Oil and Gas Pipe is available in 40-ft lengths, with beveled or square ends, and in all diameters from 22 in. ID to the largest permitted by common carriers. We can grit-blast, prime, enamel and wrap the pipe to your specifications.

Pipe made of Mayari R was used at this and eleven other compressor stations along the new 1840-mile Texas-New York gas line.

NEED A GAS HOLDER?

Bethlehem is an old hand at designing, fabricating and erecting all types of gas holders.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

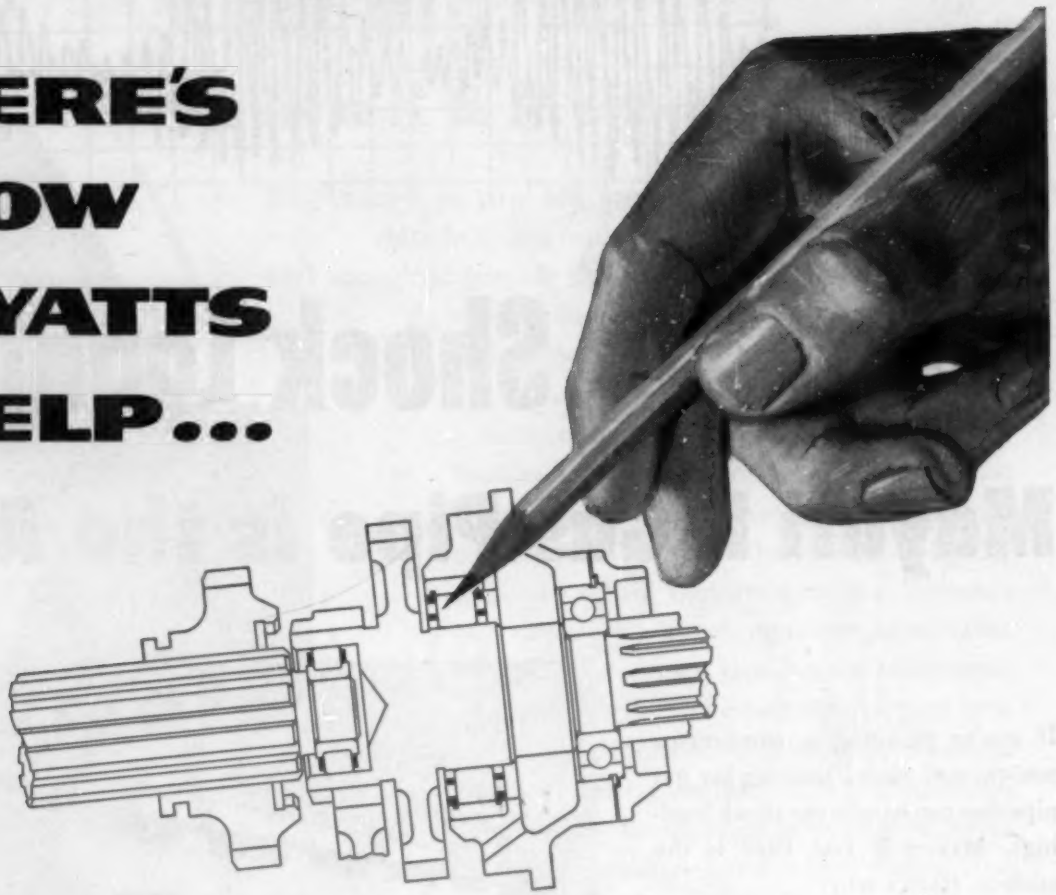
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

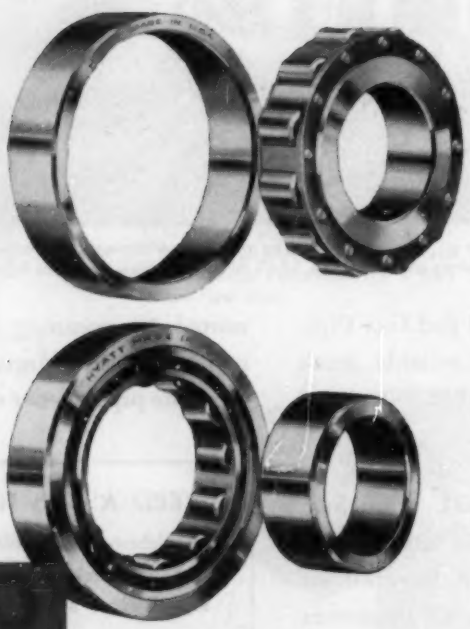
BETHLEHEM STEEL

BETHLEHEM OIL and GAS PIPE

when LIMITED SPACE is a design factor

HERE'S HOW HYATTS HELP...





Sometimes a fraction of an inch is the difference between a simple design modification and costly re-tooling. And the engineer who is thoroughly familiar with Hyatt Roller Bearings will know a lot about how to save those fractions. He'll know, for example, that to gain greater shaft rigidity with the same size housing, he need only check his Hyatt catalog for a separable inner race type of bearing. This type—available in a wide range of sizes—may be applied with the rollers operating directly upon the surface of a suitably hardened and ground shaft. Thus, a larger-diameter shaft may be used without sacrificing bearing capacity, or a larger-size bearing may be used without changing the size of the shaft. For a copy of Hyatt's latest catalog, No. 150, write to Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

STRAIGHT BARREL TAPER

You can weld this pipe with a brush

That's the only tool it takes to make field joints with Republic Semi-Rigid Plastic Pipe. And all you use are some thinner and welding solution.

It's done in five easy steps. And five minutes after the joint is made, it can be handled for normal pipe laying. After setting for twenty-four hours, a well-made joint is stronger than the pipe itself.

The line can carry high paraffin crudes, sour crudes, salt water and raw gas, both sweet and sour. Or you can use it for any other flow line service within recommended pressure and temperature limits.

There's no question about saving time. It's just a matter of how much. Booklet No. 603 will give you all the facts about Republic Semi-Rigid Plastic Pipe, along with Republic's new Flexible Plastic Pipe for water lines. Write for it.

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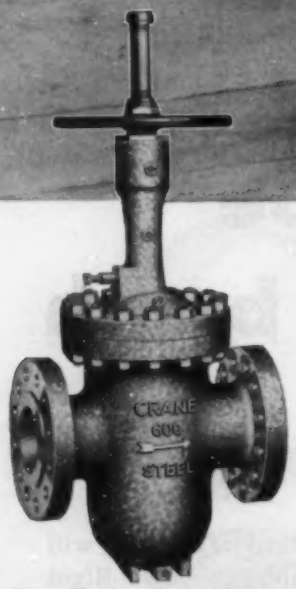
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

REPUBLIC PLASTIC PIPE
SEMI-RIGID AND FLEXIBLE

Other Republic Products include Casing—Tubing—Line Pipe—Bolts, Studs, Nuts and Rivets—Heat Exchanger Tubes—Steel Buildings



Crane Pipe Line Gate Valves are made in Full-Way or Venturi patterns for working pressures up to 1440 pounds, oil or gas. Sizes 2 to 30 inch.

Dependable CRANE pipe line valves

CLASS 600 GATES

As new pipe lines are laid, more and more Crane Pipe Line Valves go in . . . to become a permanent part of the landscape.

The reason for the popularity of Crane Pipe Line Gates is their outstanding dependability. Even infrequent operation won't affect their efficiency. That's because all working parts are sealed in grease to assure smooth operation and positive closure of the dual-seating double disc. There's no problem of erosion either, since disc is fully seated in open position as well as closed position. Special plasti-packing forms a tight and durable stem seal.

And to assure smooth, clear flow with minimum pressure drop, Crane designed the conduit-type disc ports to coincide exactly with the seat openings. There are no pockets to catch dirt or cause turbulence. Read all about this pipe line favorite in your Crane 53 Catalog and in Circular AD-1864 available from your Crane representative, or write direct.

THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON

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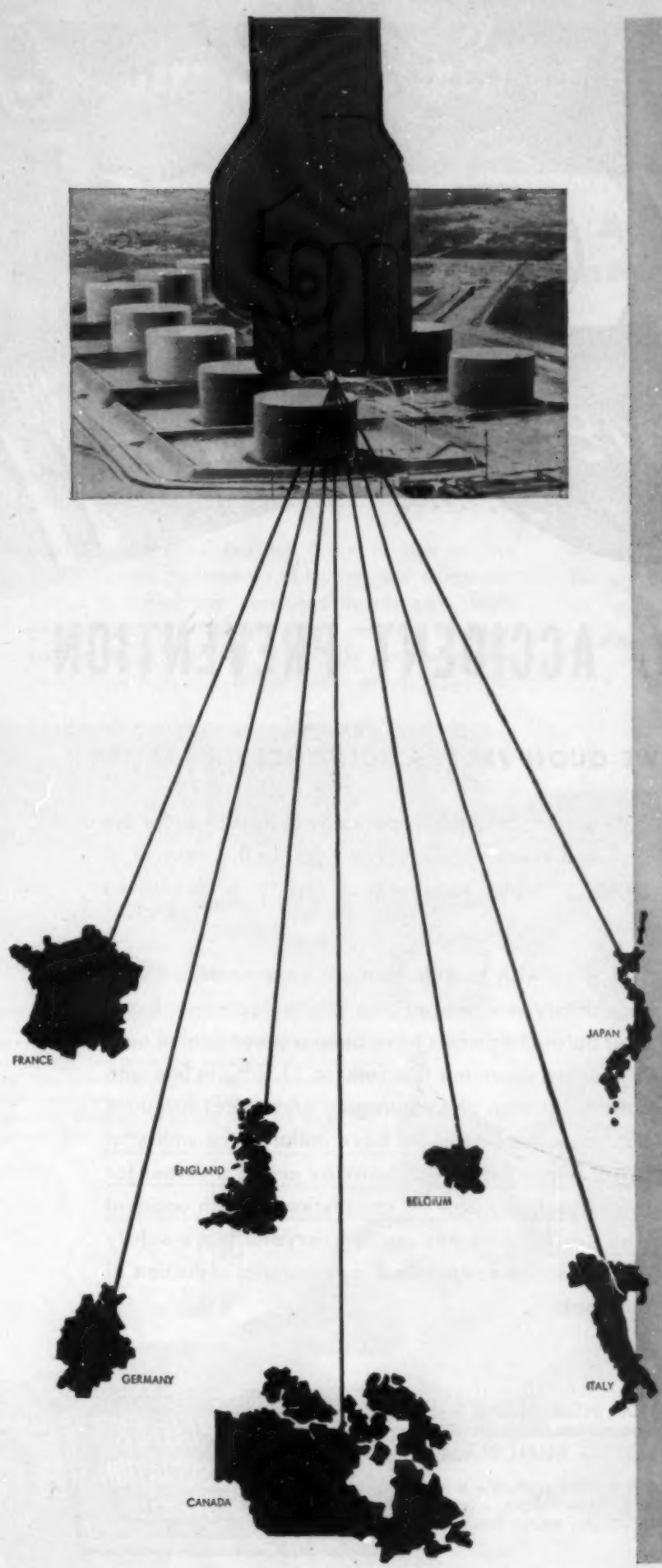

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Say

This is one of many testimonial letters received from policyholders of the Texas Employers Insurance Association. These letters tell what policyholders think of the Service and Savings received from the Association.

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for ACCIDENT PREVENTION

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"Also, we wish to state that we have received very satisfactory service from your Claims Department, and your Safety Engineers have been a great deal of help in keeping down our loss ratio to 13.38%. In line with their suggestion of encouraging employees to guard against carelessness, we have initiated the policy of rewarding the different crews by giving a dinner for them quarterly upon the completion of each accident free period. This has made everyone more safety conscious and has resulted in a material reduction of accidents."

Largest Writer of WORKMEN'S COMPENSATION INSURANCE *in Texas*

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Magcobar Processes Barite Aggregate For Immediate, Low Cost Barge or Bag Shipment to Pipeliners

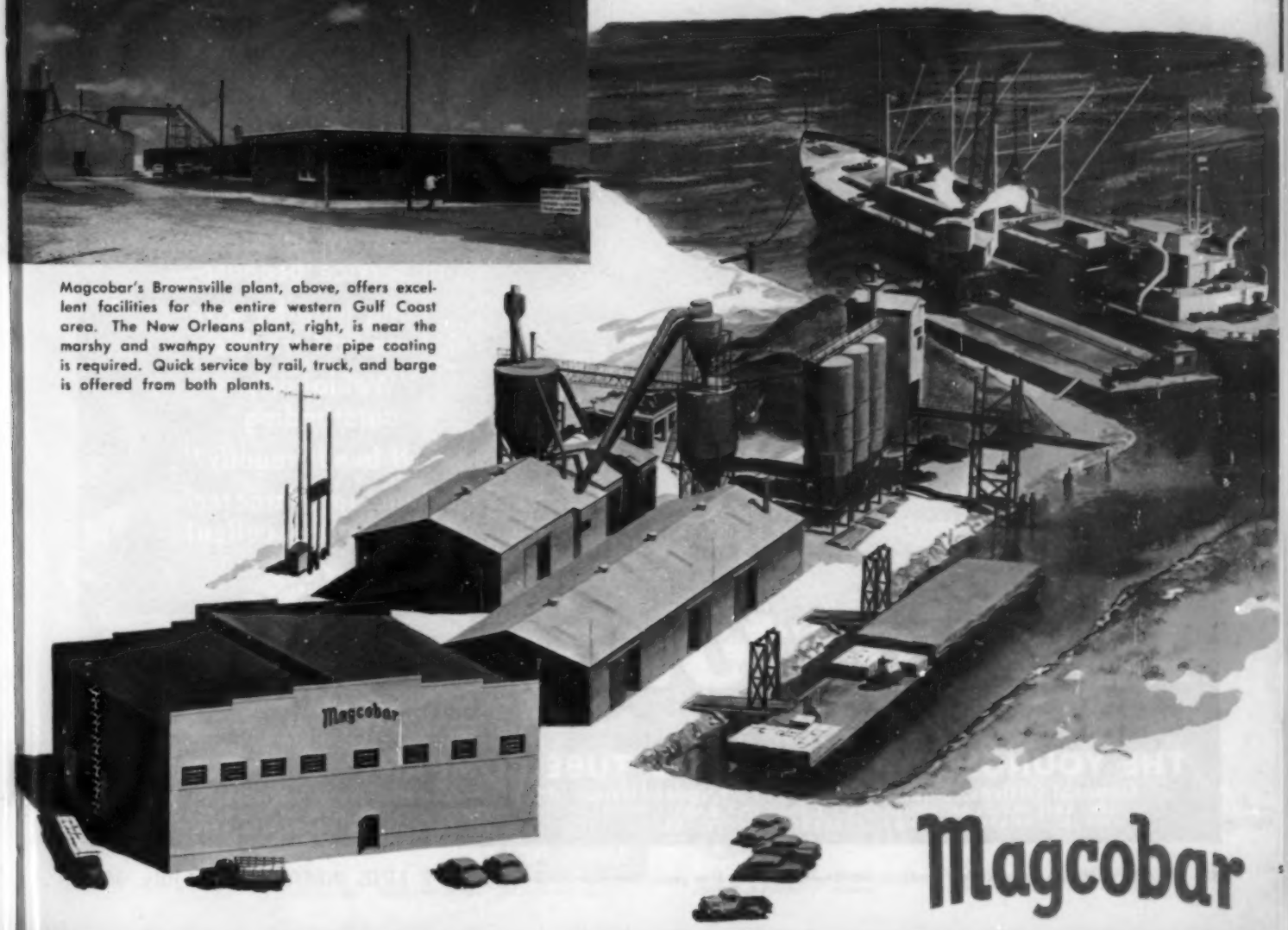
Magcobar Brand Barite Aggregate is the superior weight material for coating pipe for river crossings, marsh, swamps, and at sea. Barite-Aggregate holds the pipe down while protecting it. River clamps are not necessary. The same Barite Aggregate that *protects* your pipe *holds it* down.

The Magnet Cove Barium Corp. is one of the world's largest producers of barite, and Magcobar Brand is mined and processed in our own facilities, subject to rigid laboratory control. Its guaranteed specific gravity of 4.25 is your assurance of uniform high weight per unit volume. Magcobar Brand Barite Aggregate is available at our New Orleans plant on the Industrial Canal and at our Brownsville plant near the deep water port of that city. Barge loading facilities are available at both locations.

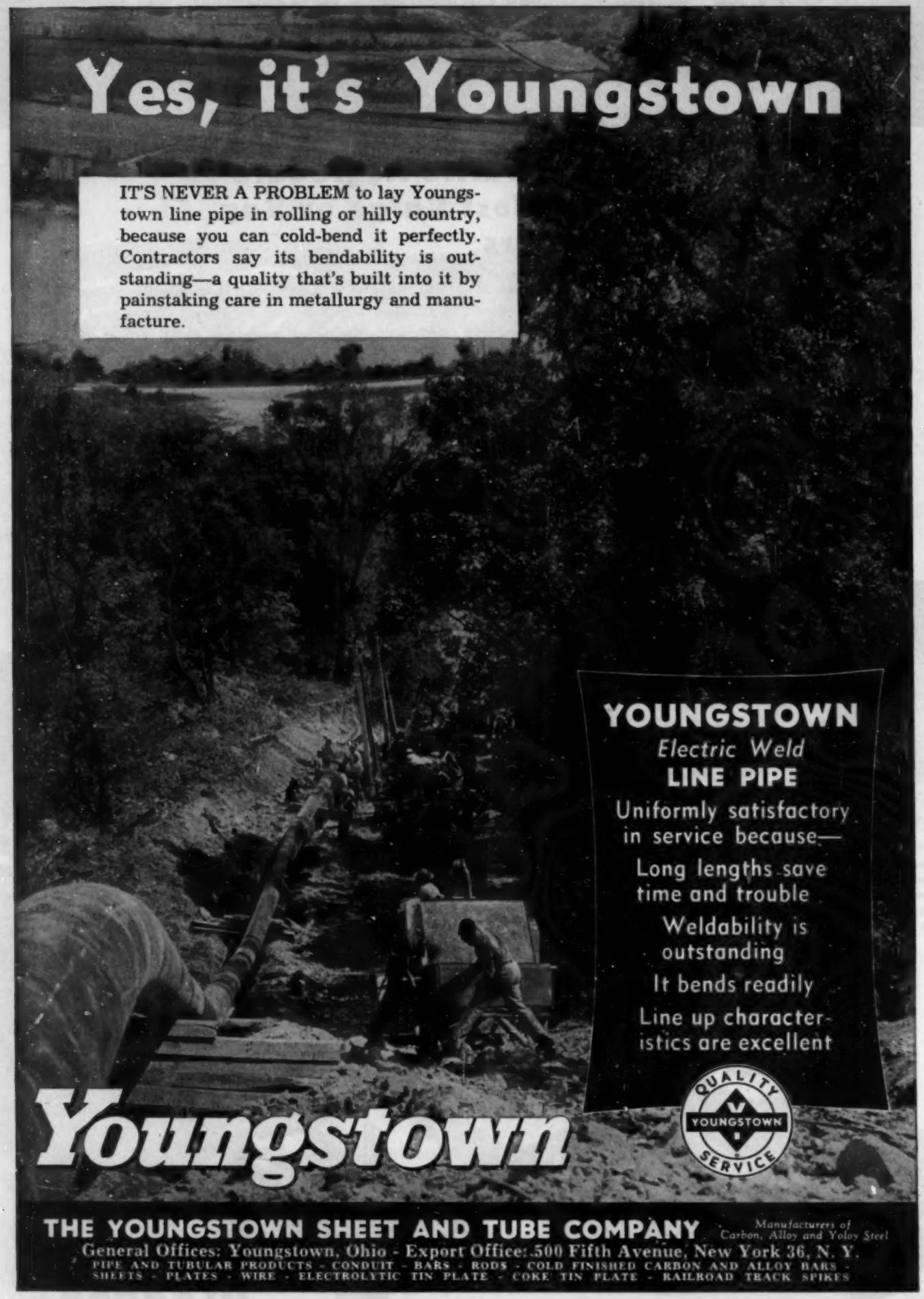
For price quotation or further information write or call Industrial Sales Division, Magnet Cove Barium Corp., P. O. Box 6504, Houston 5.

MAGNET COVE BARIUM CORPORATION
HOUSTON, TEXAS
ONE OF THE DRESSER INDUSTRIES

Magcobar's Brownsville plant, above, offers excellent facilities for the entire western Gulf Coast area. The New Orleans plant, right, is near the marshy and swampy country where pipe coating is required. Quick service by rail, truck, and barge is offered from both plants.



Magcobar


Yes, it's Youngstown
IT'S NEVER A PROBLEM to lay Youngstown line pipe in rolling or hilly country, because you can cold-bend it perfectly. Contractors say its bendability is outstanding—a quality that's built into it by painstaking care in metallurgy and manufacture.
YOUNGSTOWN
Electric Weld
LINE PIPE
Uniformly satisfactory in service because—
Long lengths save time and trouble
Weldability is outstanding
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YOUNGSTOWN
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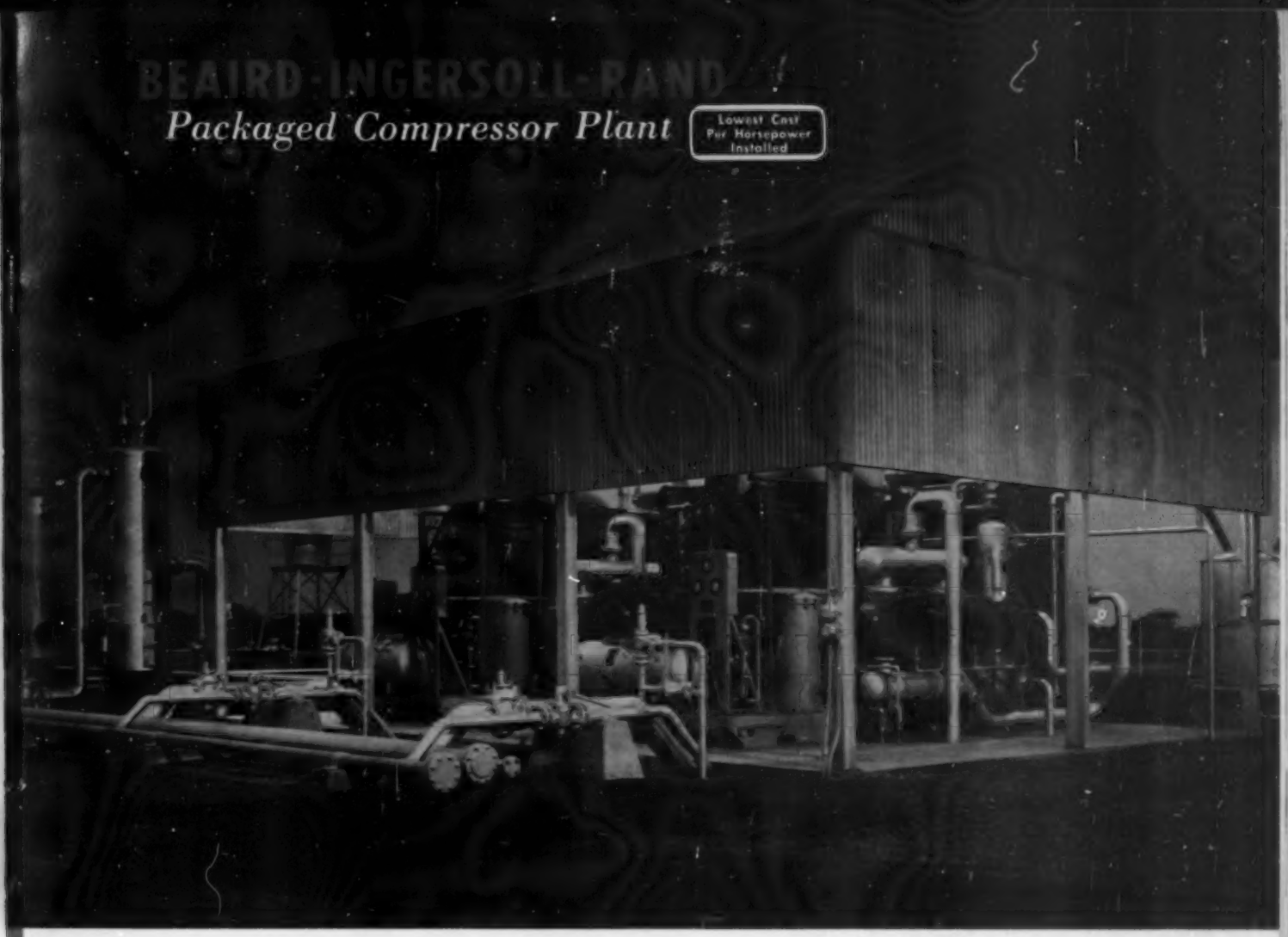


This packaged compressor plant is complete with two Beaird-Ingersoll-Rand 6SVG, 360 h.p. gas engine driven compressors, Young radiators and all necessary equipment and controls. Other sizes from 110 h.p. to 660 h.p.

Operating Profits Increased —

PACKAGED COMPRESSORS OPERATE GAS LIFT . . . CONSERVE FLARE GAS

SEABOARD OIL COMPANY designed their Plymouth compressor station to meet rapidly increasing gas lift requirements and to convert to profits 1,500,000 cubic feet of gas being flared daily.

With an eye toward future development of the field two Beaird-Ingersoll-Rand packaged compressors were installed. These units have a combined capacity of 3,140,000 Std. cu. ft. of gas per day when operating with suction at a constant pressure of 28 psig and discharging at 750 psig. Necessary controls are incorporated in the design to operate at discharge pressures ranging from 750 psig to 1000 psig. There is ample capacity for gas lifting and the delivery of excess gas into the sales line.

Designed into Beaird's flexible packaged compressor is an automatic speed control to adjust for variations in the rates of gas production. The #1 unit is operated at constant speed while the speed of the #2 unit is automatically increased or decreased to maintain a constant suction pressure.

A plus feature of the Plymouth station is its automatic operation. Built-in controls guard the plant day and night against sudden changes in operating conditions. The entire installation has required no additional personnel.

Beaird packaged compressor plants are also adaptable to gas boosting, repressuring, air compression, refrigeration, pipeline testing and other services in the field where gas is compressed.

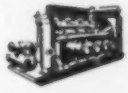
Let us show you how a Beaird-Ingersoll-Rand packaged compressor plant can be designed to meet your requirements.

THE J. B. BEAIRD COMPANY, INC.

Shreveport, Louisiana

BEAIRD

MACHINING MANUFACTURING STEEL WAREHOUSE


PACKAGED COMPRESSOR PLANTS

CAST STEEL FITTINGS

PRESSURE BULK STORAGE

ANHYDROUS AMMONIA EQUIPMENT

LP-GAS SYSTEMS

Operation Underground

TRANSCONTINENTAL GAS PIPE LINE CORPORATION

Beneath a dozen states, Transcontinental lines carry natural gas from the southernmost tip of Texas to the industrial East and the boroughs of New York. We have added a new phase to the nation's economy by serving this vast multi-state metropolitan market . . . a market we helped to create by delivering gas from the enormous Texas-Louisiana reserves to industry and homes of the eastern seaboard. We are proud of "operation underground." It is the realization of our vision of a new outlet for the Southwest's tremendous natural resources.

Engaged in making a market for Texas-Louisiana natural gas

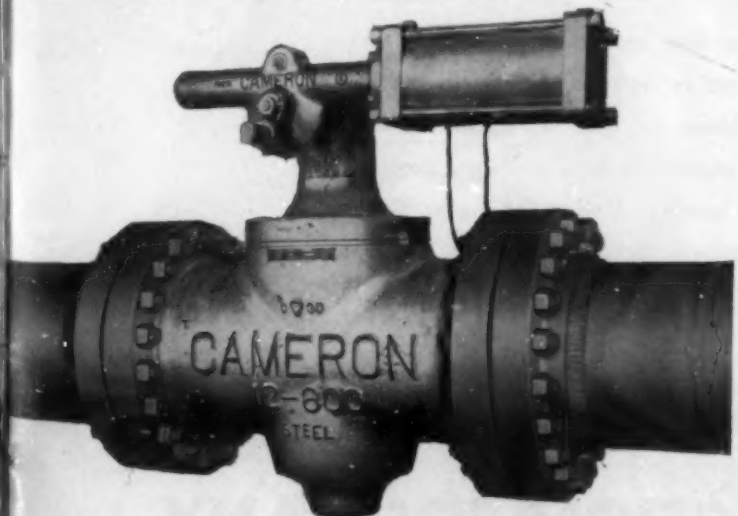
SET 'EM AND FORGET 'EM

Cameron Valves NEED NO LUBRICATION

ADVANTAGES:

- **Saves lubrication maintenance.**
- **Banishes lubricant inventory.**
- **Prevents contamination of line products and fouling of delicate measuring instruments.**
- **Does away with sticky, difficult operation.**
- **Eliminates necessity of special lubricants for special services.**

Economy note: Permanent installation — need never be replaced. Complete overhaul without removing Valve from line. Welding ends save cost of flanges.



The new Cameron Pneumatic-Hydraulic Valve Operator installed on a Cameron Lift-Plug Valve.

Unlike ordinary valves, Cameron valves seal tightly without lubricants of any kind. This is due to the precision-ground seat being separate from the body and, therefore, unaffected by body distortion resulting from temperatures, pressures, and line strains. Cameron valves operate with minimum effort because the plug is lifted free of the seat before turning it, thus eliminating friction.

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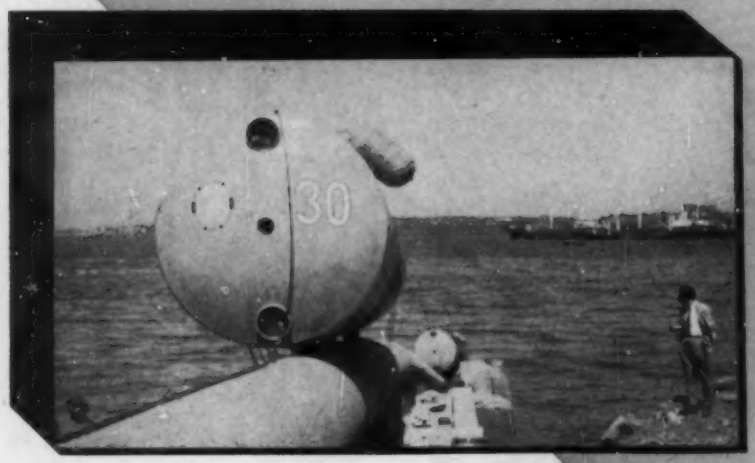
Collins Construction Company



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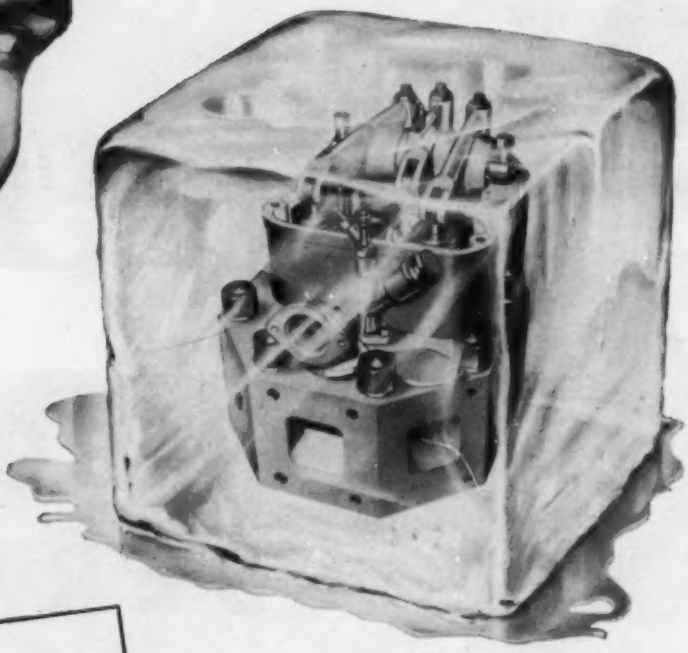
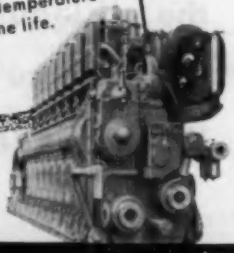
Enterprise Diesels keep a Cool Head



Check these points on the Enterprise Cooling System

- Engines operate at correct temperatures ...never too hot or too cold.
- Large water passages provide for adequate water circulation through cylinder head, and assure uniform cooling of inlet and exhaust valves.
- Elimination of blind pockets in circulating system overcomes "hot spots."
- Cylinder liners are kept at best temperatures for efficient heat transfer and reduced liner wear.
- Reduced wear due to proper temperature control prolongs useful engine life.

There is nothing finer in Heavy-duty Diesels!



No hot spots, improved operation, reduced wear ... assured by ENTERPRISE controlled temperature

Close engine temperature control is given special attention by ENTERPRISE engineers. Thirty-four years of continuous research has produced these modern engines that never run too hot or too cold in any critical area or part!

Correctly engineered circulation maintains a controlled temperature differential along the entire effective cylinder length and through the cylinder heads. This efficient, uniform cooling affords protection against wear and from stresses induced by large temperature differences.

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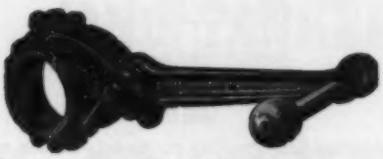
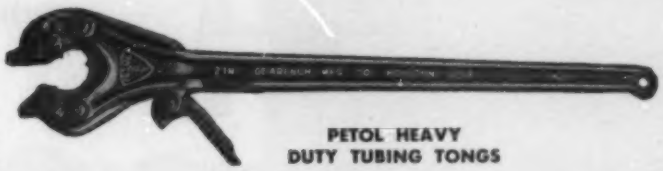
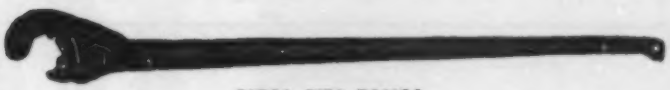


PETOL STABBING TONGS

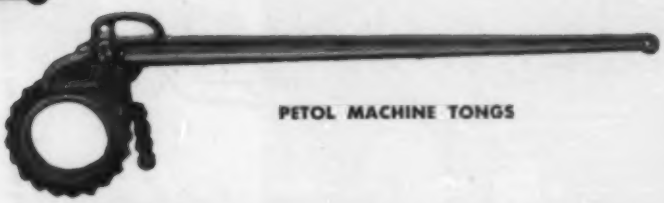


PETOL HEAVY DUTY TUBING TONGS



PETOL PIPE TONGS

TITAN PIPE TONGS



PETOL MACHINE TONGS

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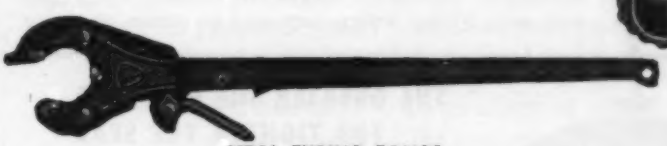
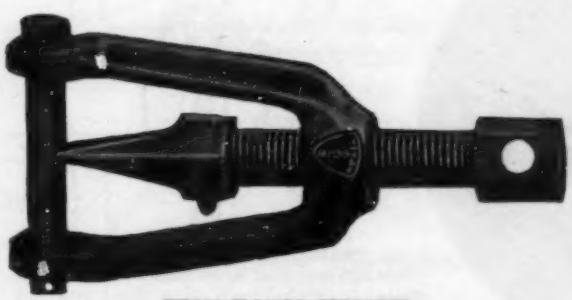
TITAN REVERSIBLE CHAIN TONGS



PETOL TUBING TONGS

PETOL FITTING TONGS



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A TYPE FOR EVERY PURPOSE

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A SIZE FOR EVERY EQUIPMENT
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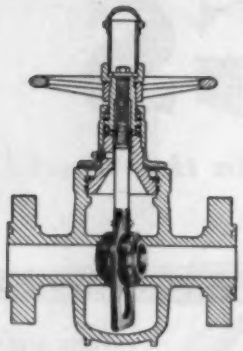
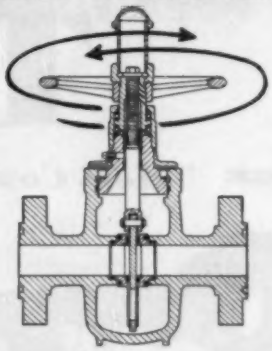
Here's everything you want in a gate valve

POSITIVE SHUTOFF—TIGHT AS A LINE BLIND



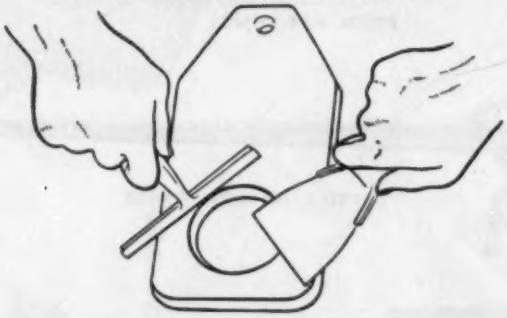
Positive dead-tight seal with pressure on either side of gate. Grove Seal-"O"-Ring Gate Valves also serve as a line blind.

LOWEST TORQUE—OPENING AND CLOSING



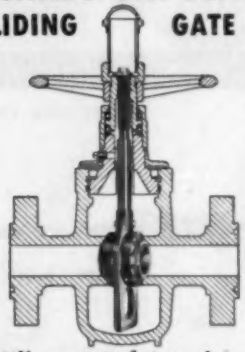
Parallel-sided full-opening port plate is non-wedging, non-galling, non-distorting. Torque required to open or close valve is less than other types of gate valves.

DUAL SELF-CLEANING ACTION



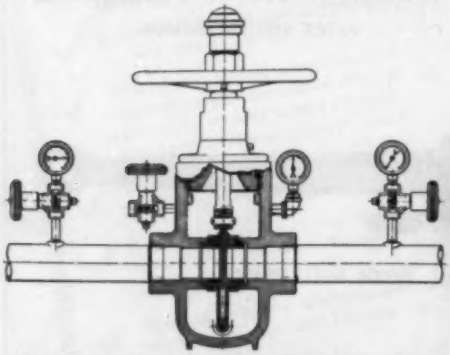
Steel seat assemblies and resilient "O" ring seals are in constant contact with full-opening port plate. Seating surfaces are stripped clean, squeegeed and polished with each operation.

FULL-FLOATING. SELF-ALIGNING FREE-SLIDING GATE ACTION

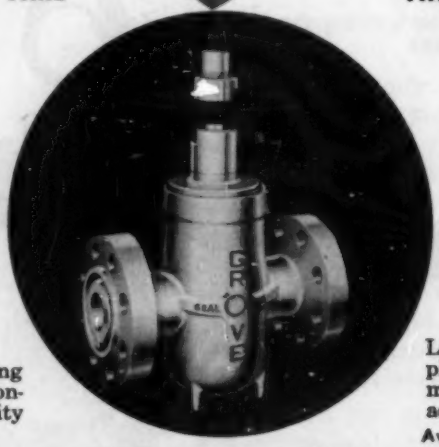


Open, closed or throttling, port-plate and seats are free-floating for perfect self-alignment, constant dead-tight seal, easy sliding action, imposing no strain or stress.

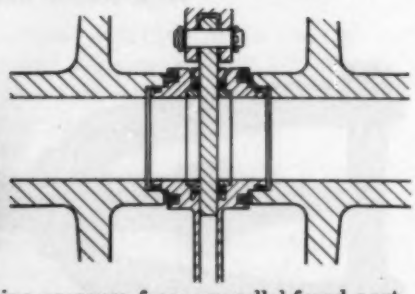
CHECK IT IN THE LINE—ANY TIME



Freedom of gate can be checked by turning hand-wheel, without "breaking" the seal. Non-variance of gauge pressure on body cavity verifies dead-tight seal of valve.



THE GREATER THE PRESSURE THE TIGHTER THE SEAL



Line pressure forces parallel-faced port plate against seat assemblies for positive metal-to-metal seal plus dual sealing action of resilient "O" rings.

Available through leading oil field supply houses

GROVE SEAL-"O"-RING Gate Valves

GROVE REGULATOR COMPANY • 65th & Hollis Sts., Oakland 8, California

HOUSTON 4—1901 Calumet St. • **LOS ANGELES 6**—1930 W. Olympic Blvd. • **NEW YORK 17**—415 Lexington Ave.

GROVE SIMPLICITY ACCURACY SAFETY

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PREVENT CORROSION and RUST FORMATION

IN STORAGE TANKS, PRODUCTS PIPE LINES AND TANKERS WITH

KONTOL 77

Kontol 77 prevents corrosion and rust formation in facilities for handling finished products. It is an oil-soluble organic inhibitor, and can be used effectively in the prevention of corrosion in products lines, tankers and storage tanks.

Extensive research and commercial usage have proved Kontol 77 to be an effective preventive of rusting caused by the presence of oxygen in finished petroleum products.

Kontol 77 has no harmful effects on product quality. For example 100/130 octane gasoline, treated with 14 p.p.m. shows no change in color, octane number, accelerated gum, precipitated lead or other av-gas specifications.

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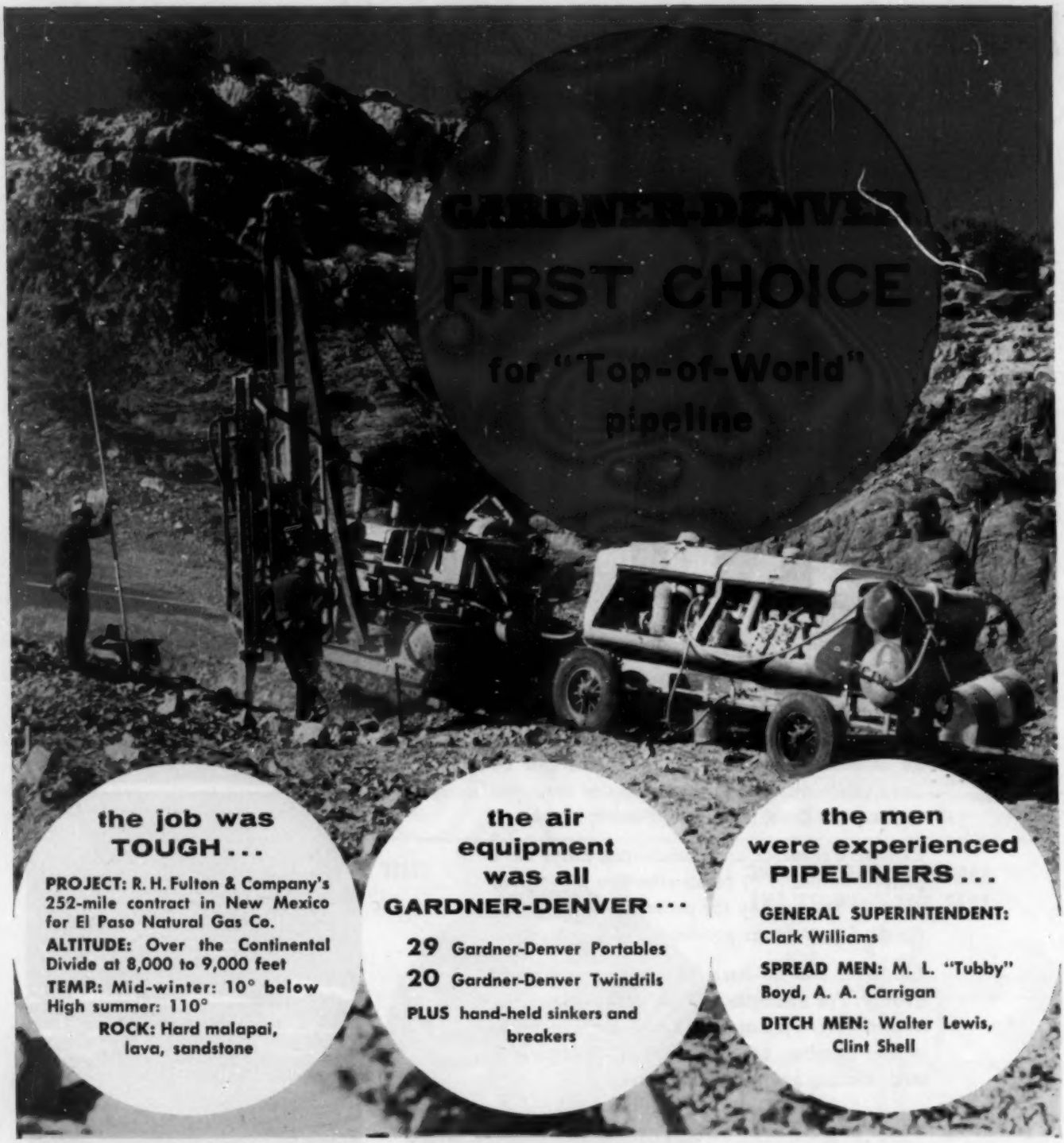

SINCE 1859

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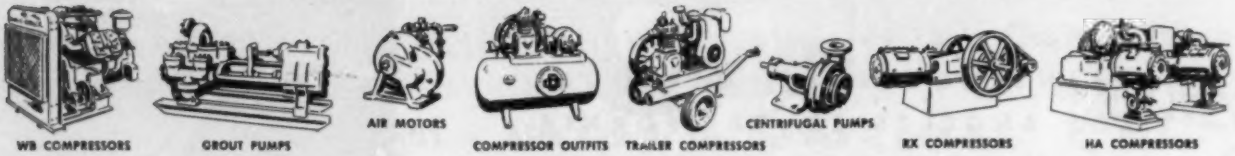

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS
FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

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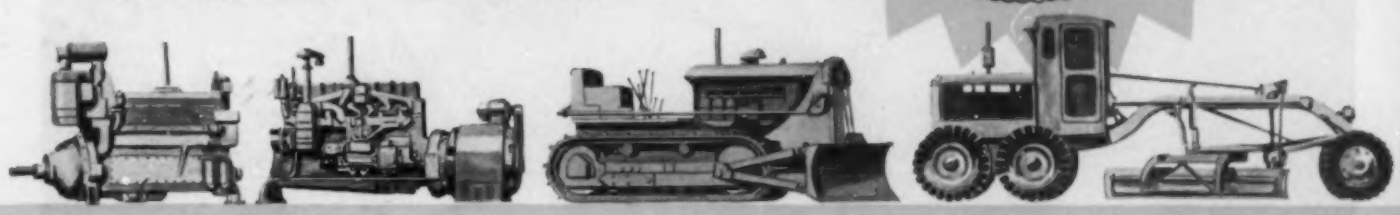
You can rely on a BONDED BUY

Only from your CATERPILLAR DEALER—
a $10,000 GUARANTEE on used
Caterpillar-built oilfield equipment.
Other big values in units of any make.



Your Caterpillar Dealer feels that there is enough risk in drilling without taking chances on used equipment. And he's backing up his words with money.

Right now he is ready to offer you a "BONDED BUY" on used Caterpillar-built equipment, backed by a bond of $10,000 issued by The Travelers Indemnity Company. Not only are you getting reliable Caterpillar-built machines with many hours of good service left in them, but you get $10,000 worth of protection!

That's not all. Your Caterpillar Dealer is offering two other classes of used equipment—"Certified Buy" and "Buy and Try." These cover used units of *any* make.

What's your need? Drilling? Slush pits? Rig lighting and electric power? Access roads? Rig moving? Winching? It doesn't matter because your Caterpillar Dealer has used equipment for every use—*all backed in writing.* Whether you need a tractor, a motor grader or workhorse drilling engines, he has honestly-tagged equipment to meet your needs.

Save yourself time, trouble and money. See your Caterpillar Dealer, headquarters for the best buys in new and used equipment!

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

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BEST BUYS IN NEW AND USED EQUIPMENT

You KNOW what you're buying from your CATERPILLAR DEALER!

Only your Caterpillar Dealer offers you these three clear-cut classes of used construction equipment. He backs them in writing. See him for the best values on the market!

(1) **"BONDED BUY."** Only the best in used Caterpillar-built equipment. Each "BONDED BUY" machine is backed by a Dealer's Guarantee Bond equal to the purchase price of the machine up to a maximum of $10,000. This provides a guarantee for thirty days against unsatisfactory performance due to defective parts. If a part should prove defective within the guarantee period under the normal conditions of your job and with proper maintenance, your dealer will put your machine back into operating condition *with no charge to you for parts and labor* up to the amount of the bond. This bond is backed by The Travelers Indemnity Company. Your Caterpillar Dealer gives it to you, at no extra cost, with your purchase of a "BONDED BUY" machine. Look for the "BONDED BUY" symbol—it's your assurance of the best in used equipment.

(2) **"CERTIFIED BUY."** The second classification of used equipment, "Certified Buy" covers machines of any make in good condition. Your performance guarantee is in writing backed by your Caterpillar Dealer.

(3) **"BUY AND TRY."** Bargains in used machines of any make. Buy and try them for a period mutually agreed upon by you and your Caterpillar Dealer. Each "Buy and Try" machine carries his written "money-back" agreement.

"BONDED BUY" ***assurance effective in the United States and Canada***

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DIESEL ENGINES • TRACTORS • MOTOR GRADERS • EARTHMOVING EQUIPMENT

1. Works Harder . . .

Bucyrus-Erie's Individual Design throughout means that every part of the 22-B is designed to work at peak efficiency, that power is right for the load, and that all parts are fully coordinated for faster, smoother digging cycles. Lost time and waste motion are eliminated. The machine *works harder,* day after day.

2. Lasts Longer . . .

Individual Design means not only fewer wearing parts, but less wear and tear on all parts, thus less maintenance and longer life. Liberal use of anti-friction bearings rides power to point of application with a minimum of wear. Bucyrus-Erie machines have earned a reputation for staying on the job, wherever they work.

See your Bucyrus-Erie Distributor for the full story of Individual Design on the 22-B dragshovel . . . the really dependable trenching machine for pipeline work. 19E54

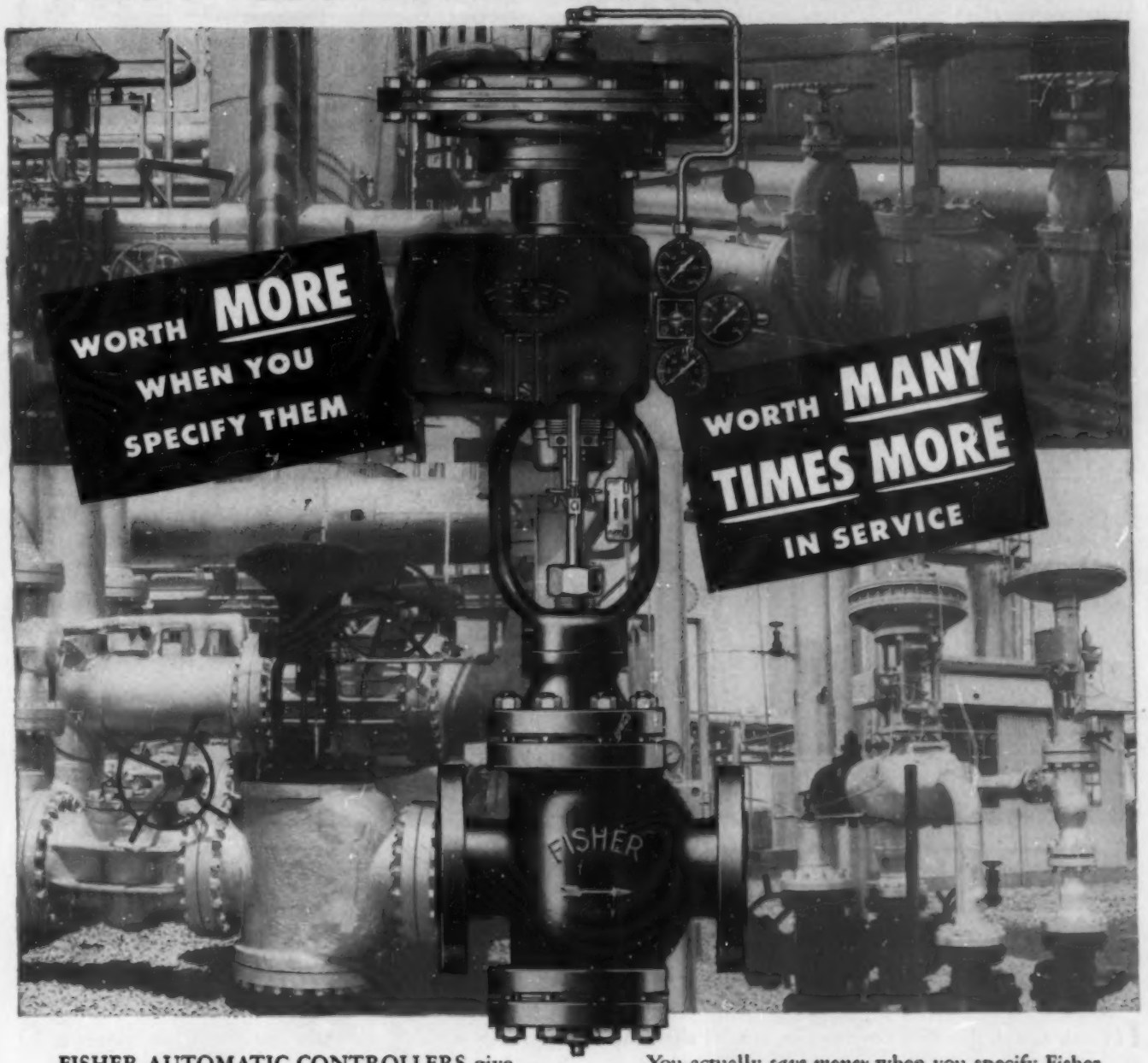
*** Individual Design**

. . . means that each model in the Bucyrus-Erie excavator line is designed from the ground up to handle its rated load. There is no over-powering or over-dippering to create "new" models. Proper proportioning of all parts means that none are too large or too small, too heavy or too light for the stresses they must carry.

Bucyrus-Erie Company South Milwaukee, Wisconsin

FISHER

Automatic Controllers



FISHER AUTOMATIC CONTROLLERS give you *more for your money* because they *stay on the job*—minimizing "out-of-service" production expenses that quickly amount to many, many times the cost of the controller.

You actually *save money* when you specify Fisher Pressure Regulators—Pump Governors—Liquid Level Controllers—Pilot Operated Regulators—Lever and Float Valves—Intermitters—Gas Regulators—Valve Positioners.

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WORLD LEADER IN RESEARCH FOR
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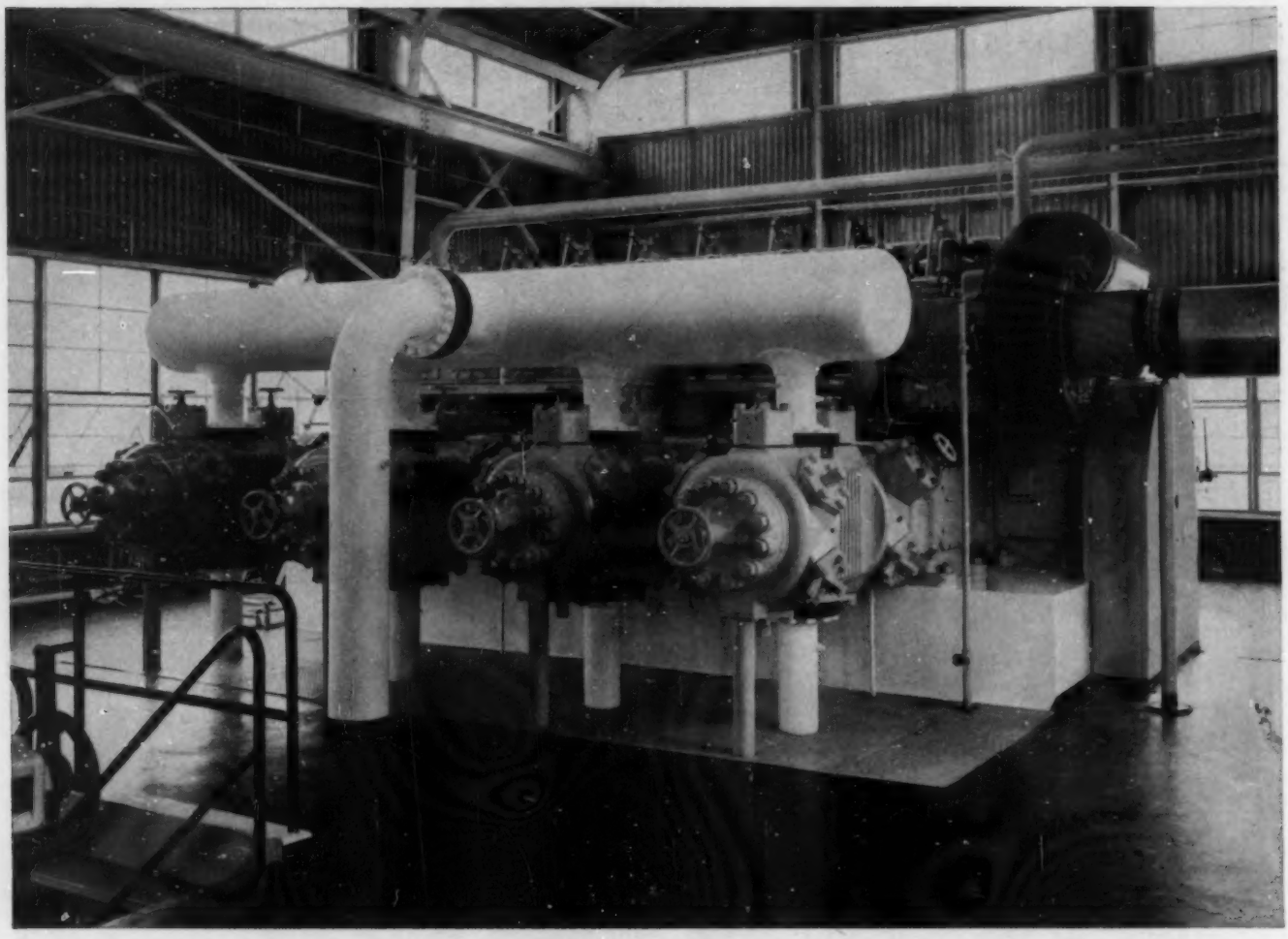
FISHER Since 1880

New Clark Turbocharged Compressor on Tennessee Gas Transmission Pipeline shows improved operating economy



The simple, clean-cut design of both turbocharger and compressor is shown in this view of Tennessee Gas Transmission Co.'s TRA-8 installation. Both the new Turbocharger and Gas-Engine-Driven Compressor were designed and built by Clark as matching units.

Substantial savings in fuel, cooling water, foundation and installation realized

IT'S only natural that the Tennessee Gas Transmission Company, one of the largest capacity major trunk line systems in the country and also one of the most progressive in the field, should be among the first to install a new Clark Turbocharged Compressor.

TGT'S 99TH CLARK UNIT

The new unit, a Model TRA-8, was placed alongside 26 Clark "Big Angles" in TGT's Middleton, Tennessee compressor station, making it the 99th Clark Compressor in the Company's vast system.

FUEL CONSUMPTION LOWERED

That was back in February. What has happened since is important news for the whole industry. From the day the unit was first placed on stream at its rated 1320 BHP load, it has met or exceeded all expectations. Fuel consumption is considerably less than on units not turbocharged, checks by engineers showed. There have been no forced mechanical shutdowns. Only the usual minor adjustments which occur on any new piece of equipment were made.

RECORD ANTICIPATED BY CLARK

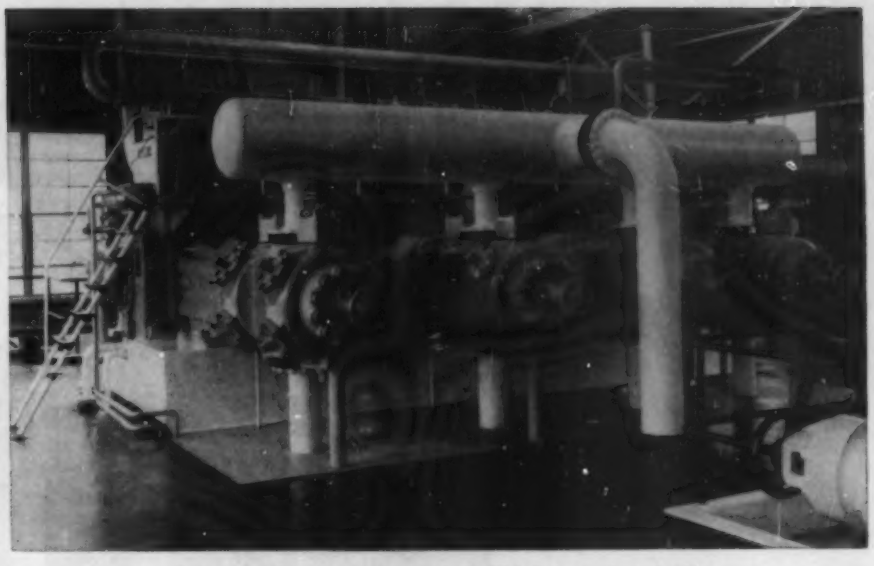
Of course, performance records such as this were not unexpected. According to Clark engineers, the TRA and TLA were specifically *designed* from the ground up as turbocharged, 2-cycle, gas-engine-driven compressors with all components perfectly matched. They were *designed* to burn 10 to 12½% less fuel, to require 40% less cooling water and to deliver considerably more power in 25 to 30% less floorspace than comparable non-turbocharged compressors.

BIG BOON TO OPERATING ECONOMY

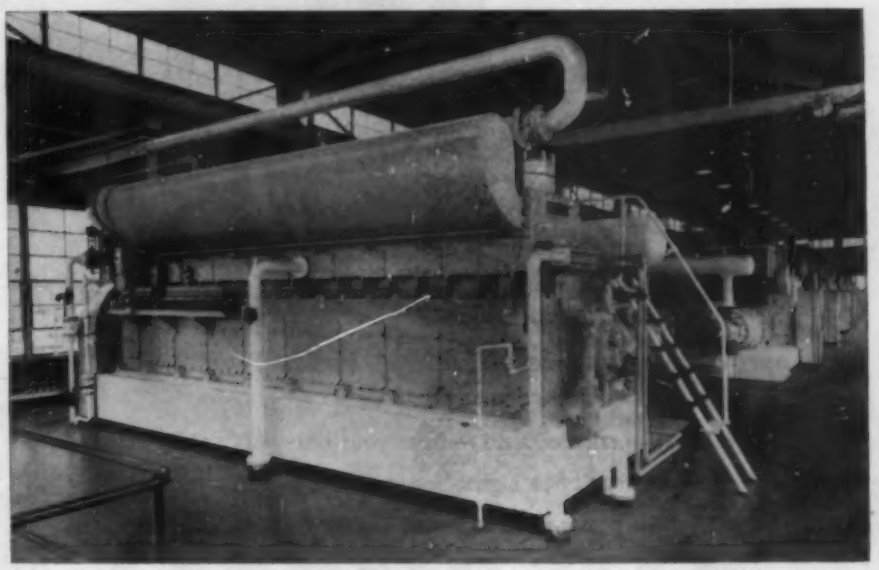
With operating economies more essential today than at any time in history, the new TRA and TLA have already proved to be one of the most practical means of decreasing compressor operating and installation costs per bhp, according to Clark engineers.

NEW LITERATURE PUBLISHED

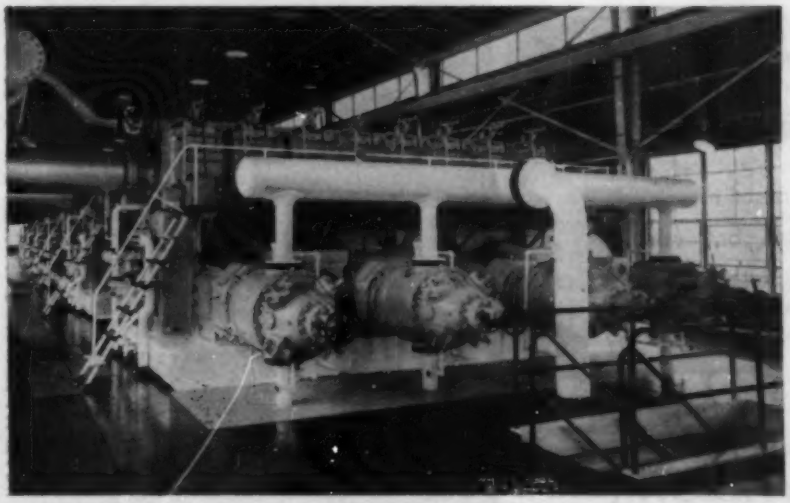
Clark Turbocharged Compressors are built in the 825-3300 BHP range. Bulletins 130 and 134, describing Models TRA and TLA respectively, are available by writing Clark Bros. Co., Division of Dresser Operations, Inc., Olean, New York.



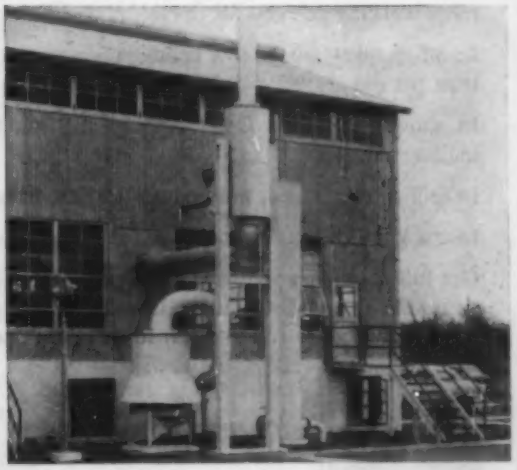
Tennessee Gas Transmission Co.'s TRA-8 is equipped with four Clark air cooled pipeline type compressor cylinders.



Minimum of piping required for Clark Turbocharged Compressor is exhibited in this view of the TRA-8, from the exhaust manifold side, at Tennessee Gas Transmission Co.'s Middleton station.



The Clark TRA-8 along with 7 Clark HBA-8 Compressors is housed in this Tennessee Gas Transmission Co. building. A total of 26 Clark "Big Angles" are housed in three buildings at the Middleton, Tenn. station.



Exterior of compressor building shows the simplicity of Clark Turbocharged Compressor installation. Notice that only one air inlet pipe, one exhaust pipe, one muffler and one air cleaner are required.

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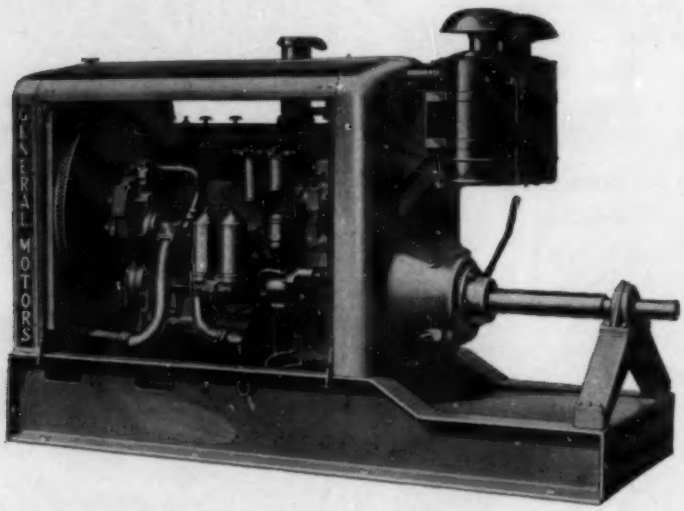

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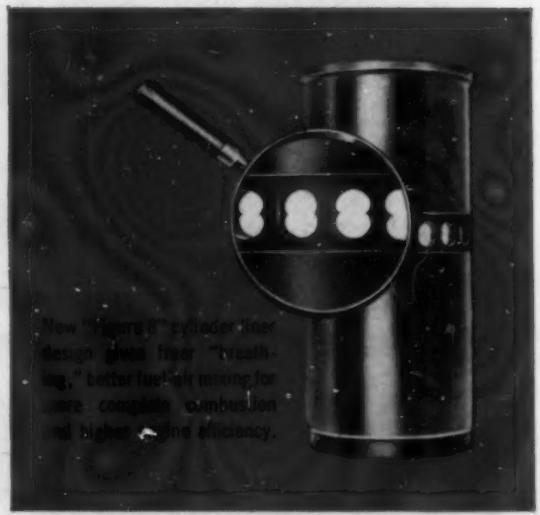

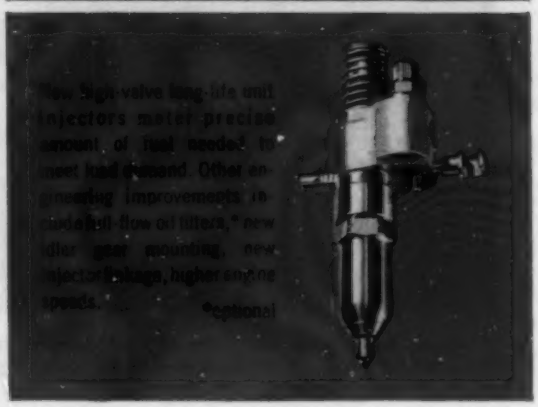

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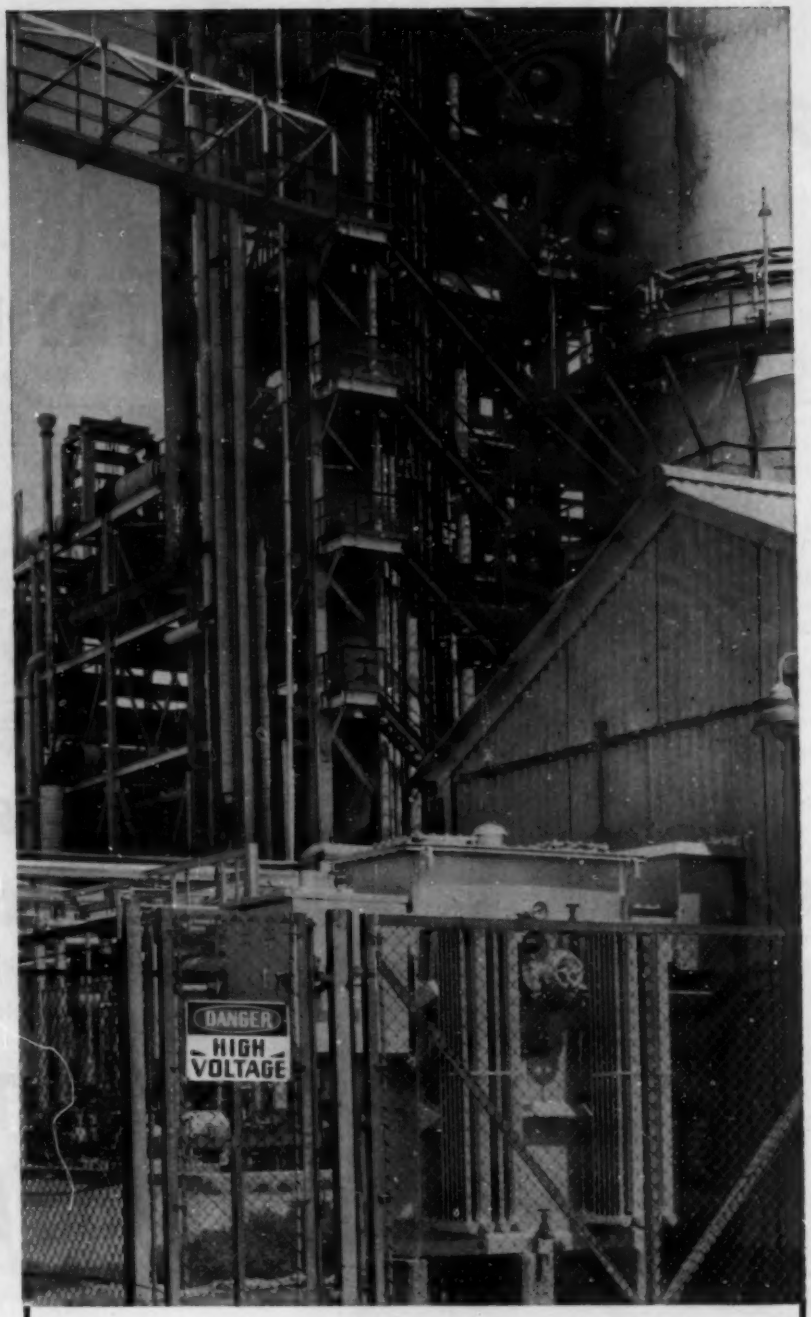

This 750 kva, 2400/4160Y to 480 volt, 60 cycle, three-phase, liquid-filled Wagner Unit Substation Transformer feeds the catalytic unit at The Carter Oil Company, Billings, Montana refinery. It is throat connected to switchgear in the adjoining building. Purchased and installed by The Fluor Corporation, Ltd., Engineers and Constructors for the Petroleum, Chemical and Power Industries, Los Angeles.

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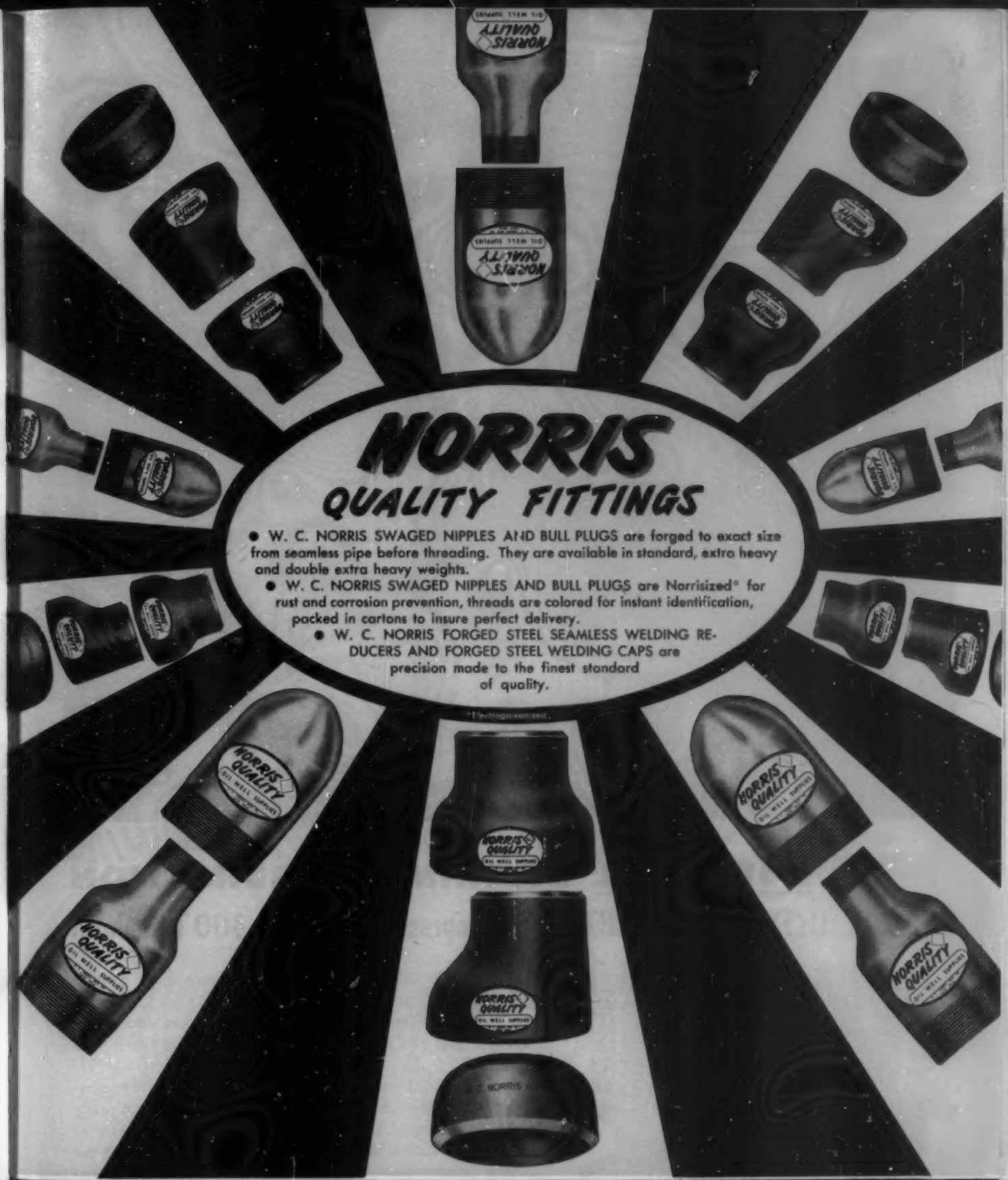
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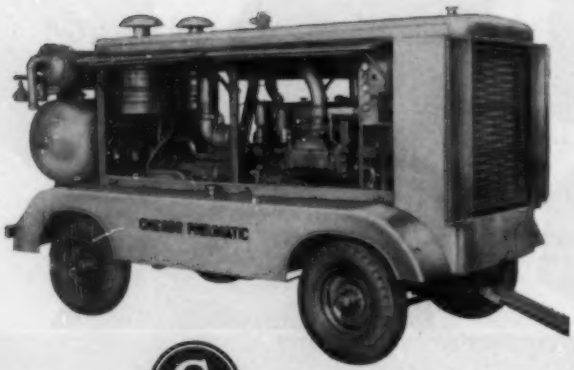

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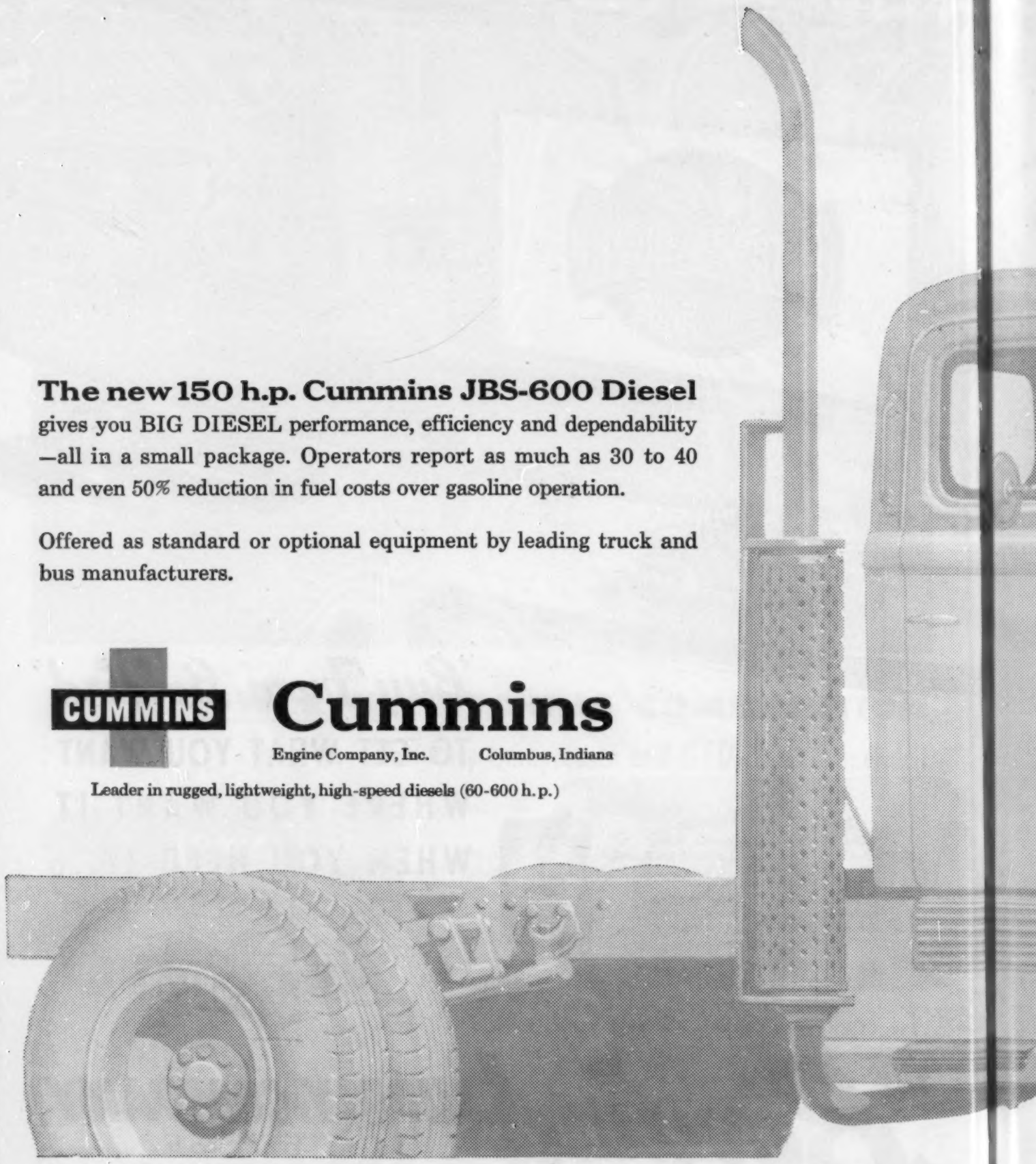

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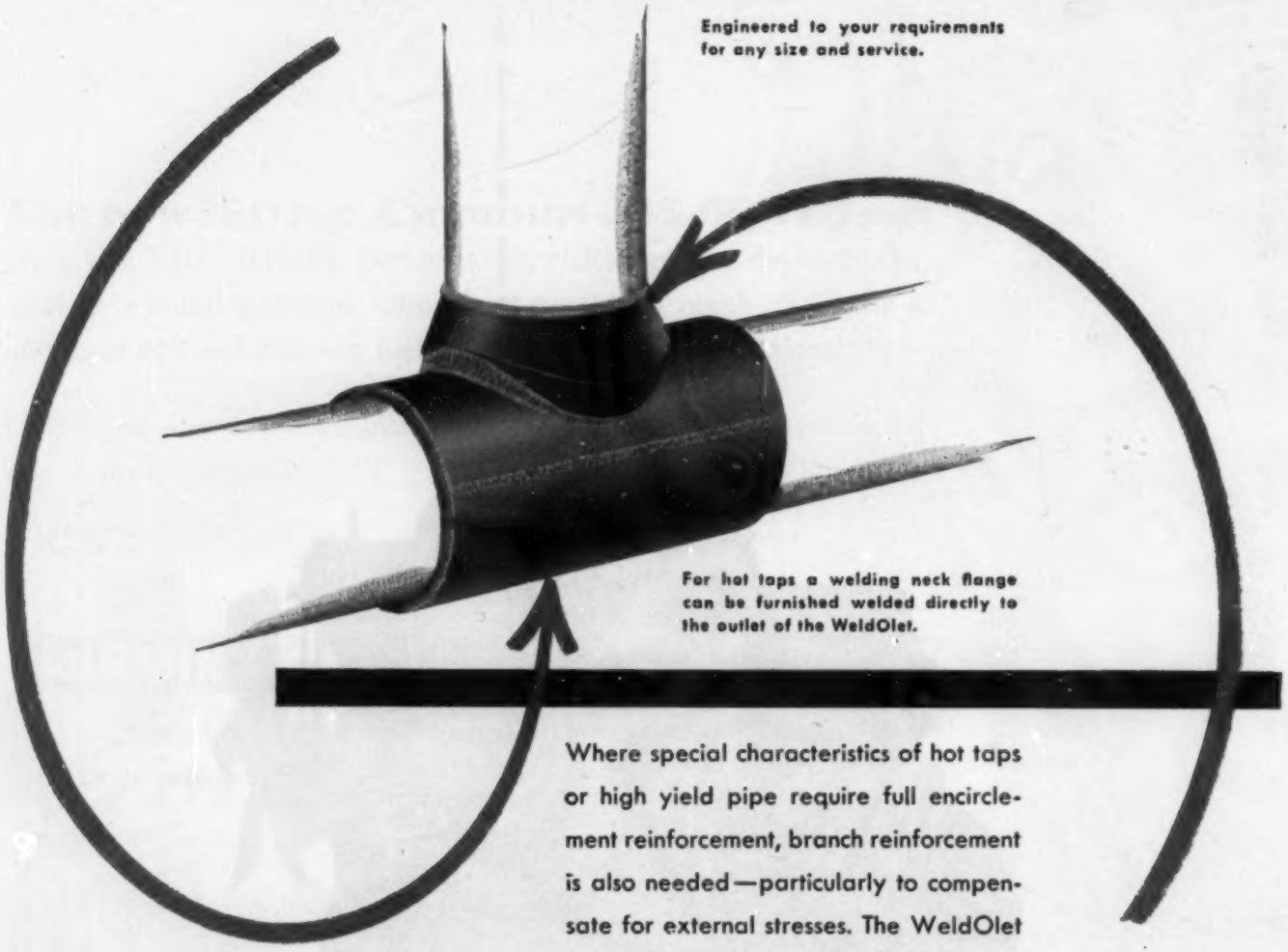

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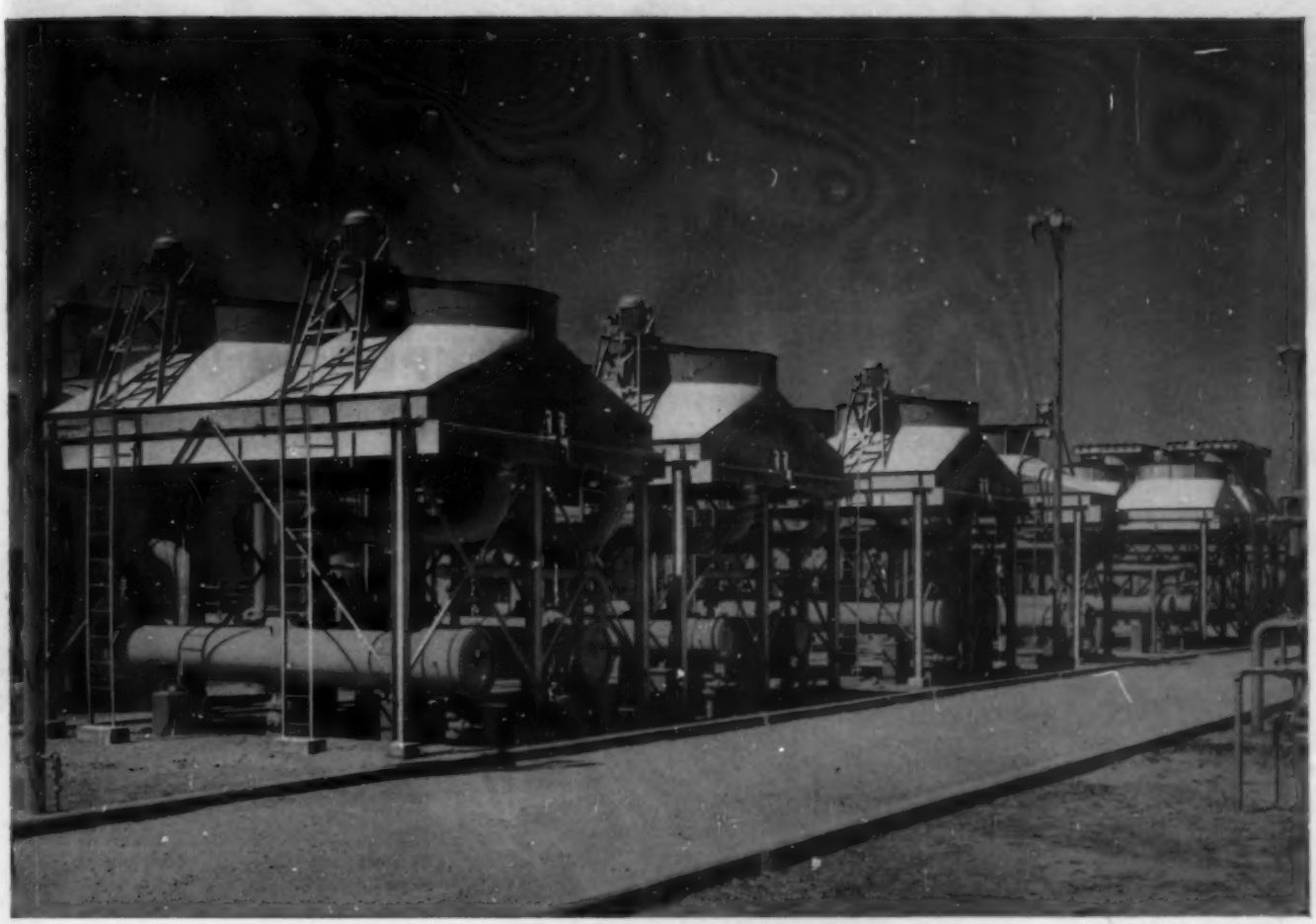

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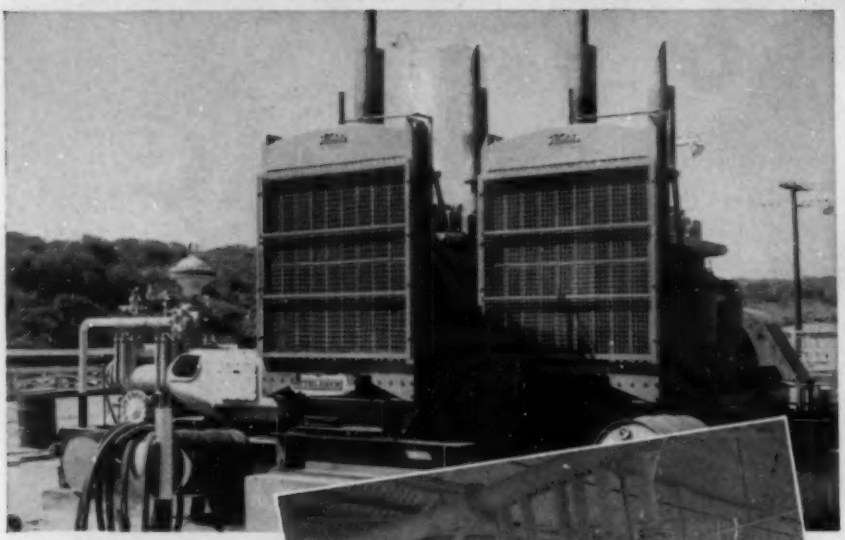

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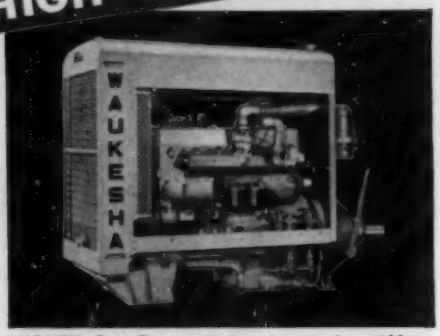

WAKBU Gas Power Unit—six cylinders, 6¼-in. bore x 6½-in. stroke, 1197 cu. in. displacement, 250 hp at 1800 rpm on natural gas.

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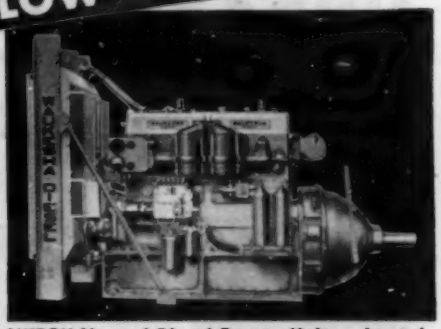
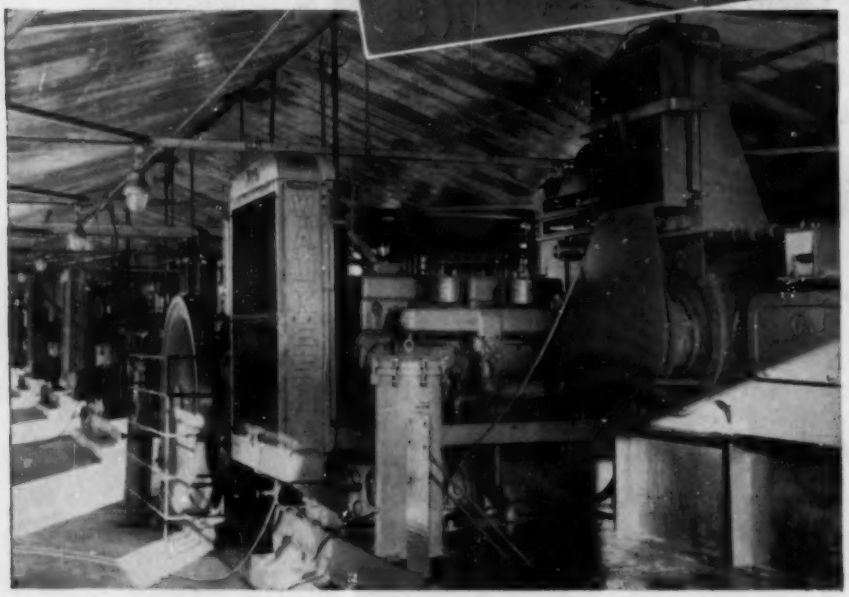


NKDBU Normal Diesel Power Unit — six cylinders, 7-in. bore x 8¼-in. stroke, 1905 cu. in. displacement, 274 hp at 1200 rpm, maximum.



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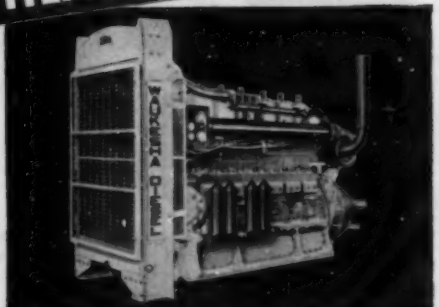

LRDBSU Turbocharged Diesel Unit — six cylinders, 8½-in. bore x 8½-in. stroke, 2894 cu. in. displacement, 526 hp at 1200 rpm, maximum.

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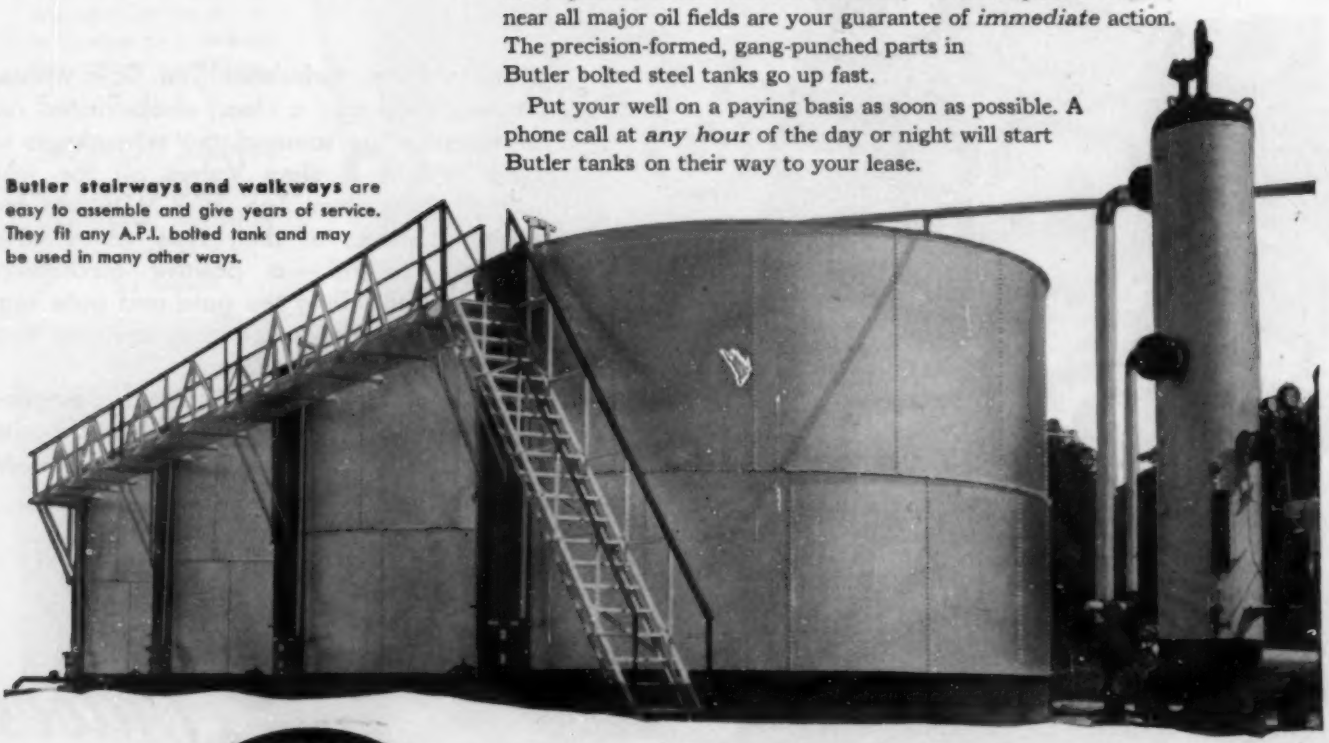

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A Pipeliner's Tractor

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- **HUSKY, 15-FT. BOX SECTION BOOM** — automatic clutch throw-out prevents bending of boom against boom stop.
- **SIMPLIFIED TRANSMISSION** — 2 forward and 2 reverse speeds for load line and boom line.
- **OPERATOR AND CREW SAFETY FEATURES** — sure-gripping, weatherproof brakes . . . big, husky brake levers, ratchets, and linkage . . . positive locking winch controls . . . massive winch drum jaw clutches . . . drop-proof counterweight linkage.

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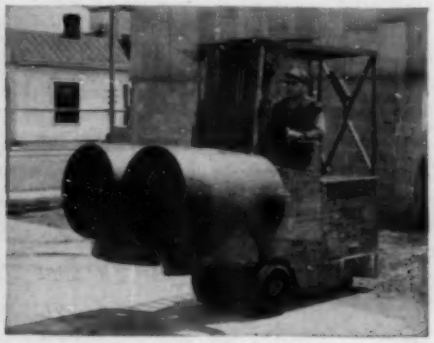

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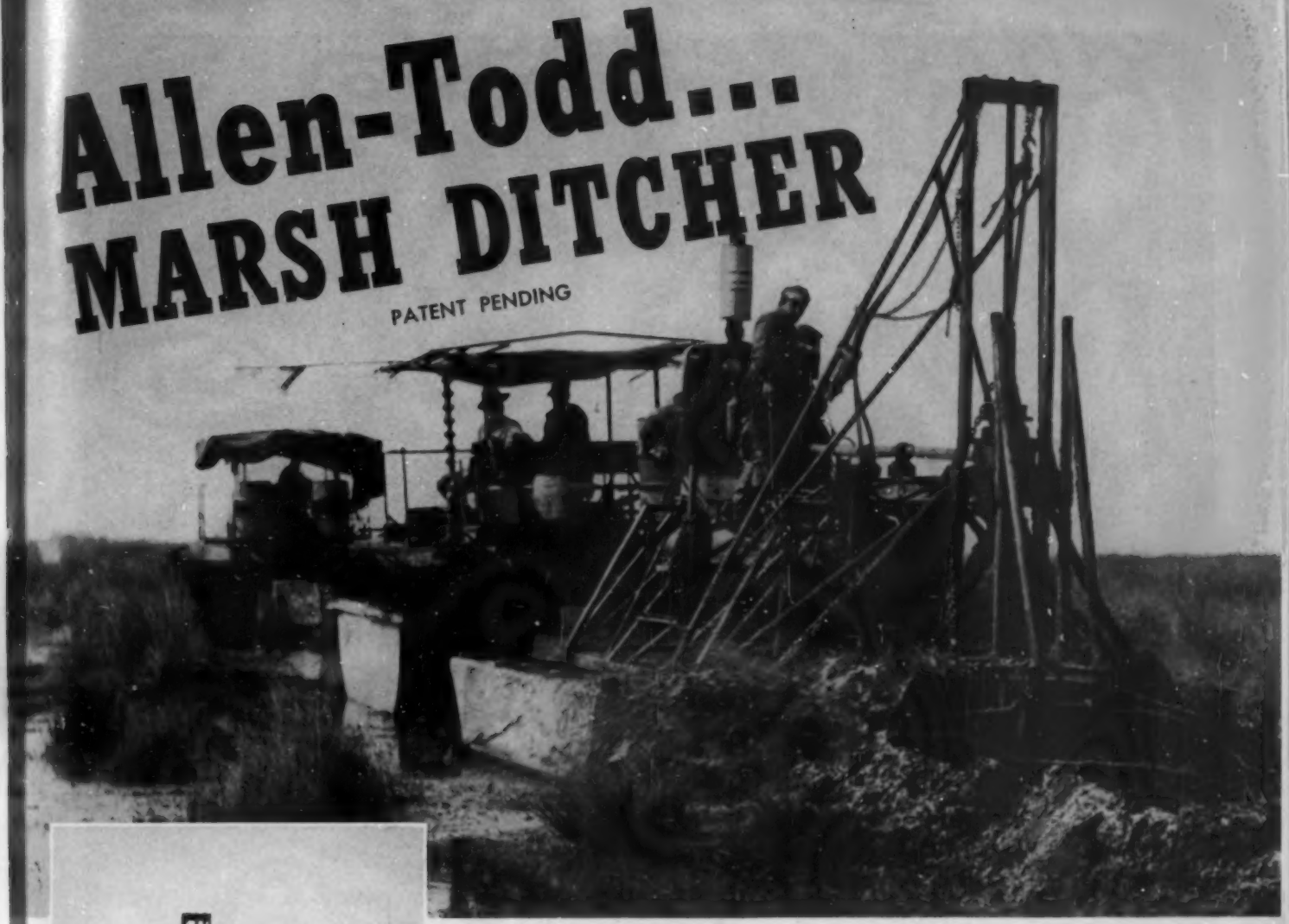

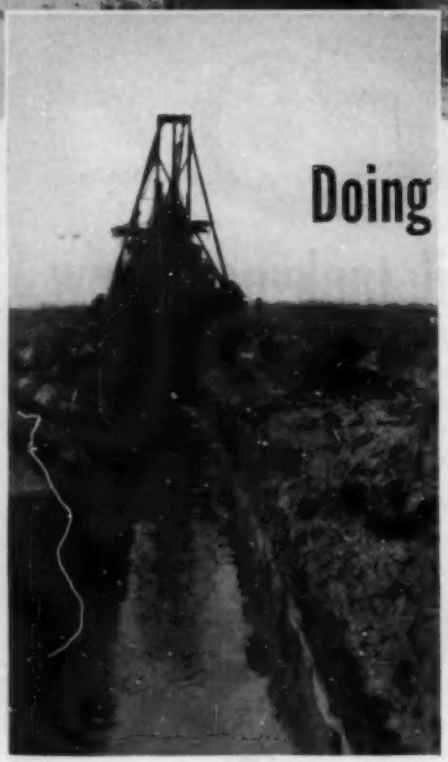

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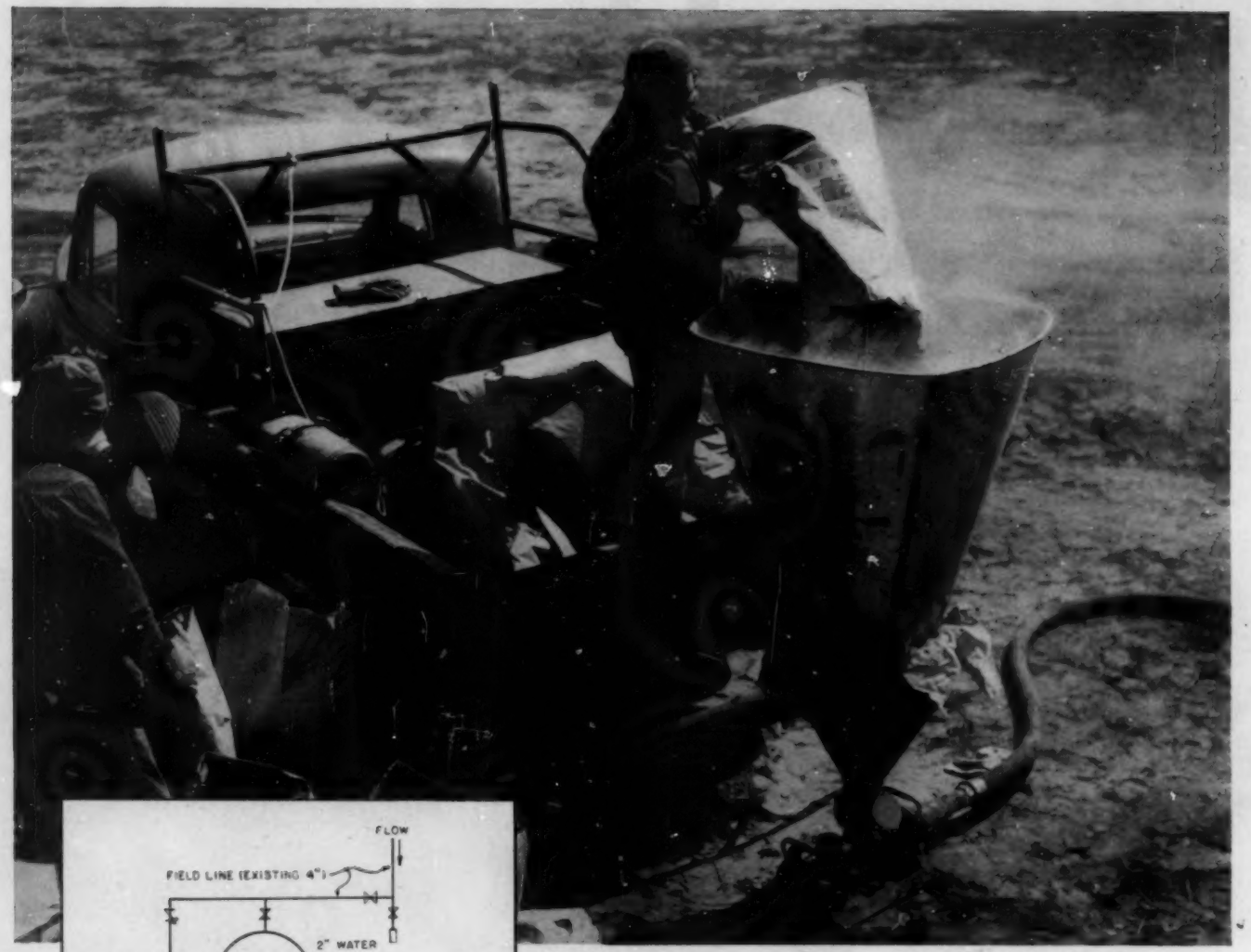

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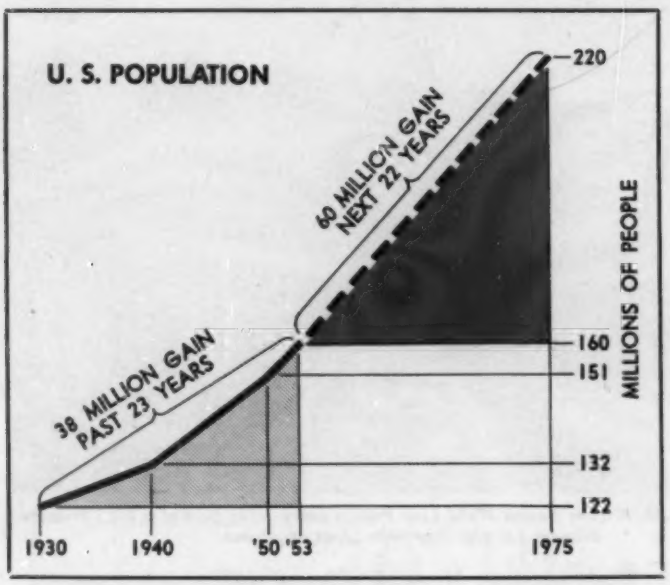
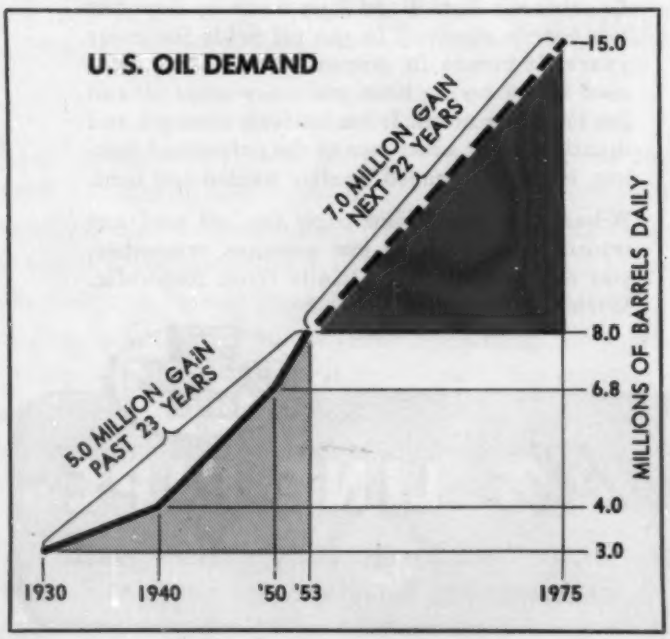
Huge Pipe Line Building

- Industry must keep pace with tremendous population growth.
- Higher consumption means more production, more pipe lines.
- Construction during next 22 years to exceed past 23 years.

By WARREN L. BAKER, Editorial Director, PIPE LINE INDUSTRY

A BRIGHT FUTURE lies ahead of the pipe line industry of the United States. Population in the U. S. is really going places by 1975, and the pipe line industry is going with it, since oil and gas consumption will be much higher.





A study by PIPE LINE INDUSTRY indicates pipe line capacity must be greatly expanded by 1975. This will necessitate high construction rates during the next 22 years.

U. S. population is to undergo a tremendous growth by 1975. People determine the market for everything, including oil and gas. Much larger consuming rates will require higher oil and gas production in future years, which, in turn, will necessitate expanded pipe line capacity.

While future construction rates probably will not hold at the abnormally high levels of the past six years, the need for expanded capacities would seem to require greater average construction than existed before World War II.

U. S. Population Boom . . .

Future U. S. population growth will be almost twice as fast as in the past. The U. S. Census Bureau has predicted that population of the country will reach 220 million by 1975, an increase of 60 million people in the next 22 years. During the past 23 years, U. S. population jumped from 122 to 160 million, a growth of only 38 million consumers.

It looks like business markets in the U. S. are just getting started. More of everything will be needed in future years as population increases—more food, clothing, homes, automobiles, etc. This also means more oil and gas will be consumed, and that additional pipe line capacity will be required to move greater quantities of oil and gas to consuming areas.

Larger Growth in Oil Usage . . .

Faster future population growth means U. S. oil consumption will increase sharply. U. S. oil demand likely will reach 15 million barrels daily by 1975, compared with 8 million in 1953. This would be a gain of 7 million barrels in daily consumption during the next 22 years, in contrast with a growth of only 5 million between 1930 and 1953.

To reach the predicted level of 15 million barrels daily by 1975, future consumption will need to increase by the conservative average of slightly less than 3 percent per annum over the next 22 years, or just over 300,000 barrels a year. Postwar growth has been above this rate of increase, so 15 million barrels per day does not seem an unreasonable forecast for 1975.

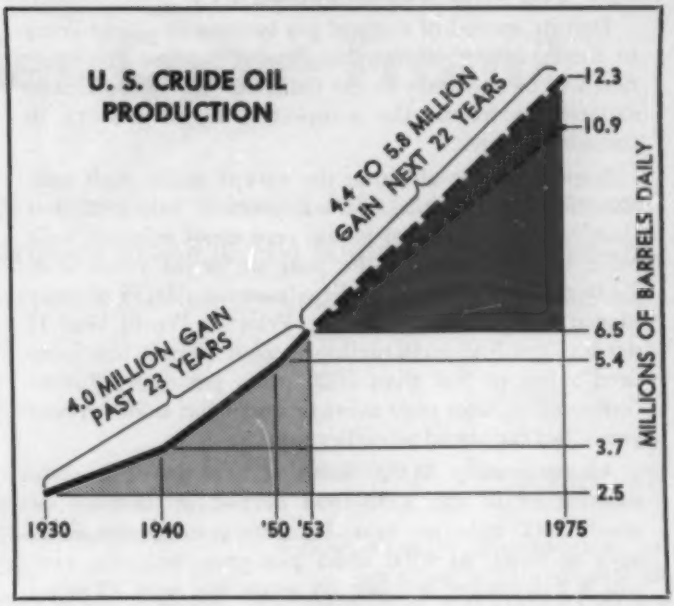
Program Ahead for U. S.

More Oil Production Needed . . .

Growing demand will require greater U. S. crude oil production. Despite enlarged imports and domestic natural gasoline output, the U. S. will need to produce more crude oil in the years ahead.

Even if imports in 1975 reach 3 million barrels daily, three times more than in 1953, and domestic natural gasoline output attains a volume of 1 million barrels per day, 50 percent larger than last year, the U. S. would need to produce 10.9 million barrels of crude oil in 1975 to satisfy estimated demand. Should imports reach only 1.8 million barrels per day (75 percent above last year) and natural gasoline output be but one-third larger, the U. S. would need to produce 12.3 million barrels a day in 1975.

Whether U. S. crude production in 1975 is 10.9 million barrels or 12.3 million barrels daily, a higher rate of growth would be required in the future than in the past. Growth during the next 22 years on this basis would be 4.4 to 5.8 million barrels in contrast with a 4 million barrel gain during the previous 23 years.



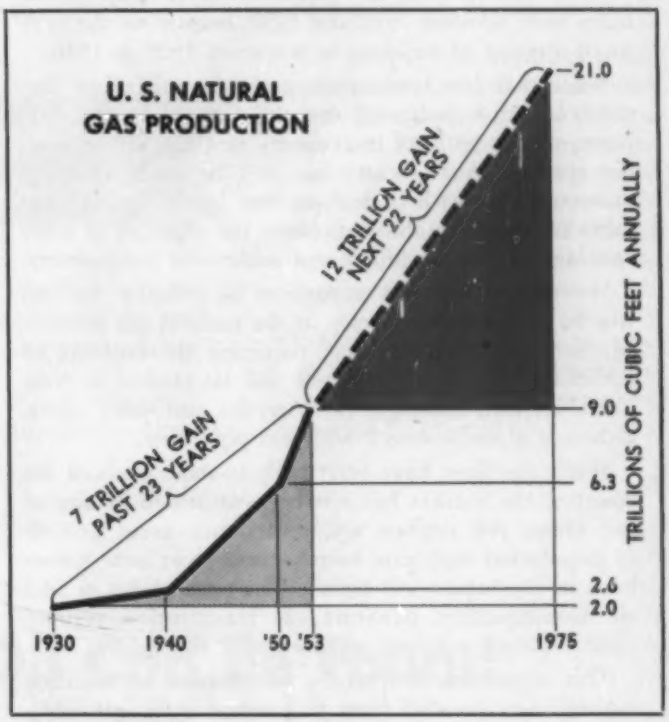
Much More Natural Gas Also . . .

Far more natural gas also will be consumed in the U. S. in the future. In addition to the effect of population growth, many industries and homes are converting to gas from other fuels.

While the day of racing for a franchise area or of taking a dump load under a boiler are largely gone, the gas industry is going to grow in scope. Gas will enter the home heating and high-grade industrial fields on a greatly expanded scale. Heavily populated and highly industrialized areas which have not been supplied with gas for any length of time offer tremendous expansion possibilities.

Several sources have estimated 2½ times as much natural gas must be produced by 1975 as in 1953. This is a conservative estimate the way marketed gas production has been growing in recent years.

This would mean annual U. S. natural gas marketed production of at least 21 trillion cubic feet in 1975, compared with 9 trillion cubic feet at present. Whereas, natural gas production rose 7 trillion cubic feet in the preceding 23 years, this forecast anticipates a rise of 12 trillion cubic feet will occur in the next 22 years.



Gigantic Future Construction Program Required . . .

The U. S. pipe line system must continue to undergo heavy expansion in the years ahead. While some reduction from the abnormally high construction rate of the past six years may be experienced, prospective growth in production seems to preclude too much of a decrease.

Future pipe line construction will have to provide enough additional capacity to handle the increase in producing volumes. The large gains anticipated for both oil and gas production between now and 1975 presage a high rate of pipe line construction. Numerous new producing fields will need gathering systems and feeder lines to trunk lines. In addition, a vastly expanded rate of building refined product systems is foreseen.

Certainly, the industry can look forward to the necessity of building more miles of new pipe line during the next 22 years than it constructed during the preceding 23 years. To achieve this end, average yearly construction is apt to be somewhat below recent ex-

ceptionally high levels but far above rates customary before 1947.

Huge Gas Line Construction . . .

Despite spread of natural gas systems in recent years to most parts of the nation, heavy gas line construction will be necessary in the future to provide sufficient capacity to handle the prospective huge growth in consuming rates.

Some tapering off from the exceptionally high construction level of the last six years is indicated, but there will be no return to the very small volumes built prior to 1947. During the past six boom years from 7000 to 10,000 miles of new natural gas lines were placed in operation annually. Prior to World War II natural gas line construction ranged from a few hundred miles to less than 2000 miles per year. Future construction rates may average somewhat under recent years, but far ahead of earlier years.

Approximately 53,000 miles of new gas lines were constructed in the 1948-1953 period, an average of nearly 9000 miles per year. If future construction averages as much as 4500 miles per year, half the rate which has existed the last six years, the next 22 years will see 100,000 miles of gas lines built. This would be in contrast with the construction of only 68,000 miles built between 1930 and 1953, because of the very small amount of building in the years 1930 to 1946.

Somewhat less transcontinental transmission line construction is indicated for the future. In the first place, most regions of the country now are served with big systems. Also greater use will be made of large diameter lines with high capacities in the future. Another factor is the ability to boost the capacity of some existing lines by installation of additional compressors.

However, continued expansion of existing systems will be an important factor in the natural gas picture. Markets will keep growing, requiring the building of additional capacity. More gas will be needed in New York, Detroit, Chicago, Los Angeles and other cities, although already served with gas pipe lines.

While gas lines have been built to most parts of the country, the market has not been saturated in any of the areas. All regions will experience great growth in population and new homes—and most new homes built in the future will burn either natural gas or fuel oil. Consequently, present gas transmission systems must undergo constant expansion in the future.

This expansion frequently will consist of building entirely new parallel lines to provide sufficient additional capacity. In other cases, loops and horsepower can be installed to increase the capacity of existing systems.

The construction of feeder and gathering systems should be at a much higher rate than in the past. As the need for additional gas production increases, the transmission companies will find it necessary to obtain their supply from a growing number of fields. Heretofore, many of the large trunk systems have depended upon a relatively small number of large gas producing fields for their supply. To connect the greater number of fields upon which they will depend in the future will require the construction of an increased amount of gathering and feeder lines than customary in the past. An important factor in this phase will be the scattered location of the fields.

Heavy Crude Line Construction . . .

Existing U. S. crude oil pipe lines do not have sufficient capacity to move the large volumes which will be needed in the future. The nation's present pipe line system is capable of handling more than the 6.5 million barrels produced daily in 1953, but cannot possibly handle the 10 to 12 million which may be required by 1975. Therefore, the industry must continue to expand its crude oil pipe line system.

Due to the tendency toward big diameter, large capacity, jointly-owned trunk systems less transmission mileage will be constructed in relationship to production growth than in the past. But, if U. S. production expands sharply in the future, new areas are likely to become important producing regions and require pipe line outlets.

The Rocky Mountain area, one of the frontiers many believe offer excellent possibilities for discoveries, may be called on to produce much greater quantities than in the past. Pipe lines would be needed to connect the Rocky Mountain fields with large refining centers before the region can expand its output very much. While a comparatively small number of large trunk lines might furnish the necessary capacity, major feeder and gathering line construction would be required because of the scattered location of fields over a vast territory.

It seems certain that the future will see more feeder and gathering system construction. Past experience indicates a steady growth in number of new fields will be needed to provide additional producing capacity. The rate of finding new oil producing fields has risen steadily from a peak of 610 in 1948 to a new high of 1080 in 1953. The number of new fields found rose from 203 in 1937 to 436 in 1947. Higher producing rates will require even larger discovery volumes in the future, so an increasing number of new fields must be found in the future. Each new field must have gathering lines and feeder systems to transmission systems.

For these reasons, future crude oil pipe line construction is not likely to fall far below the annual average of 3700 miles constructed during the past six years.

More Refined Product Lines Due . . .

Greater construction or refined product systems seems certain. The amount of product lines constructed has shown notable increase in recent years, with a special tendency toward construction of jointly-owned systems. They provide cheaper transportation than railroads or trucks.

As consumption volumes increase, such lines become more feasible and practical. These conditions prompt the prediction that a higher rate of building product lines will exist in the future than in the past.

Refined product lines may average better than 2500 miles per year in the future. This rate would result in the completion of 55,000 miles during the next 22 years. Of the 32,000 miles of product lines constructed between 1930 and 1953, much of it has been since World War II. —The End

Where Will Future U. S. Oil And Gas Supplies Come From?

To find sufficient supply to satisfy greatly expanded future oil and gas consuming rates confronts the U. S. with an enormous problem. To obtain the best thinking on this vital subject, WORLD OIL invited several leading geologists to discuss the outlook for different areas.

WHERE WILL sufficient oil and gas be found to supply the growing population of the U. S. 20 years from now? Of course, nobody knows exactly where all the oil of the future will be discovered. However, well-informed geologists can pretty well tell what general areas offer the best discovery possibilities.

While imports no doubt will be much larger 20 years hence, the U. S. will still need to produce far more crude to satisfy greatly increased consumption. (See article Page 58.) At the same time, various estimates have predicted that natural gas consumption in 1975 will be 2½ times larger than in 1953. The ability to import gas will be far more restricted, so the future gas supply is going to have to be developed within the U. S. or Canada.

To obtain opinions on the question in the first paragraph, WORLD OIL and PIPE LINE INDUSTRY asked a group of outstanding geologists to help select geologists qualified to speak authoritatively on various regions of the U. S. and Canada.

How this article was developed

These men were requested to participate in the accompanying symposium by commenting on the following questions:

- What is the outlook for future discovery of oil and gas in your district?
- Have most of the favorable oil and gas areas in your district already been developed, or are there important and sizable territories still undeveloped?
- Are geological conditions and prospective undeveloped territory such that discoveries of oil and gas are likely to be larger, the same, or less than volumes found in recent years? In other words, do you think the rate of finding new oil and gas reserves can be increased?
- What particular areas in your district offer the best possibilities for finding large volumes of oil and gas?

More Oil Can Be Found Along the West Coast

By GRAHAM B. MOODY, Chief Geologist, Standard Oil Company of California

THE WEST COAST'S economically important petroleum discoveries have been confined to California which certainly will enjoy future similar discoveries. Oregon and Washington probably will find petroleum in sufficient quantities for economic exploitation.

Some observers say that California has been explored so thoroughly that little, if any, favorable territory remains for testing. Such prematurely ossified thinking has been prominent during past decades in published comments on California's future oil prospects. Fortunately for the industry, there have been always enough optimists among California's efficient exploratory men and oper-

ators who have found petroleum in paying quantities where the pessimists said there was none.

Some significant oil showings and non-economic gas pools are the only rewards for intermittent exploratory effort in Oregon and Washington. These are, however, provocative indications of future possibilities.

Any region underlain by sufficient thickness of sediments ordinarily present in oil-producing basins must be considered as favorable for prospecting until the density of unsuccessful exploratory drilling is such that the region is definitely disproved for production. Density of drilling in Western Oregon and Western Washington has been one hole to 66 and 298 square miles, respectively.[1] Much of the wildcatting has had a distinctly promotional flavor, hence is not significant in appraising petroleum possibilities. Great sedimentary areas in Oregon and Washington are unexplored by drilling; these are favorable for possible discovery.

An extremely fine-toothed exploratory comb has traversed California's sedimentary areas. Density of exploratory drilling of one well to 1.1 square miles[2] in the Los Angeles Basin, for example, suggests rather complete testing of that region's possibilities. Exploratory holes are not evenly distributed, however; parts of the basin may have only one hole to 5 or 10 square miles. An important oil field may hide in a couple of undrilled square miles. Productive possibilities are viewed more realistically as three-dimensional anyway. Favorable petroleum regions probably are resting undisturbed beneath presently producing areas. These considerations justify the conclusion that California still has undeveloped favorable petroleum areas.

Any future discovery of economically producible petroleum in Oregon or Washington will be larger, of course, than anything found in those two states to date. California's recent discovery record is so undistinguished that it should, perforce, improve in the future. Despite the fact that California's three-year average annual discovery curve shows only two half-hearted upward bulges (1942 and 1948) since the last significant high in 1937 and has declined steadily since 1948, there are definite indications that the discovery rate will increase in the near future.

The West Coast's most likely possibilities for discovery in substantial volume include: California—offshore fields, large blocks of sediments below thrust faults, new pools adjacent to or underlying currently producing fields, geological formations and provinces that have produced little or no petroleum; Oregon and Washington—areas of exposed sedimentary rocks and blocks of sediments covered by lava flows.

Future discovery of large volumes of petroleum on the West Coast will depend on astute analysis of all factors involved in an exploratory program, unlimited courage to implement that program, and expenditure of large sums of money; a bit of luck may be the final ingredient that will determine the success of an exploratory venture or of an operator.

REFERENCES

[1] Possible Future Oil Provinces, *Bulletin AAPG*, Volume 35, No. 2 (Feb. 1951).

[2] Ibid.

Canada Can Expect More Discoveries in Future

By THEO. A. LINK, Link, Downing & Cooke, Ltd.

THE FUTURE OIL PROSPECTS for Canada are not what some occasionally appearing pessimistic "Blue Monday" newspaper headlines might lead us to believe, nor will new discoveries be made as easily as one might think after reading a high-pressure sales promotion leaflet for a newly organized oil company. Somewhere between these two extremes lies the answer to the question "What about the future oil and gas prospects of Canada now that Leduc, Redwater and Pembina have been discovered?"

Before Leduc was discovered the writer of this article "went out on a limb" and suggested that Western Canada should be good for 1½ to 2 billion barrels of oil if a certain number of exploratory holes were drilled. Since that amount of reserves and more has already been established, because sufficient holes were drilled, one should be able to make another guess, and a better one at that, because more data are now available. Likewise, at the first natural gas hearing in 1948, when the then known gas reserves were less than three trillion cubic feet, it was suggested that 10 trillion cubic feet would be found within five years. There are now more than 12 trillion cubic feet established.

The discovered oil reserves in Canada prior to Leduc (1947) were, compared to the present reserves, an almost negligible amount, but since then appreciable reserves have been added each year; large amounts some years, lesser amounts during other years. On the basis of the graph showing these cumulative increases it is quite obvious that a similar theory should work to predict future prospects namely, that the discoveries will be closely related to the number of exploratory holes drilled, plus the increase in efficiency in logging wildcat wells, plus refinements in and new geophysical prospecting devices, as well as revised or new geological thinking as additional data become available, and other improvements in both exploratory and production methods.

Optimistic view. In view of the above it is not deemed necessary to look outside the great Western Interior plains area of Alberta, Saskatchewan, British Columbia, Manitoba and Northwest territories to feel optimistic about Canada's future reserves. One should also consider the other sedimentary basin areas such as the Vancouver Island coastal basin, the James Bay portion of Hudson's Bay, Southwestern Ontario, St. Lawrence Lowlands, Gaspe, and the Maritime Provinces, but none of these appear promising enough to consider them in the same breath as the basin area of the prairie provinces.

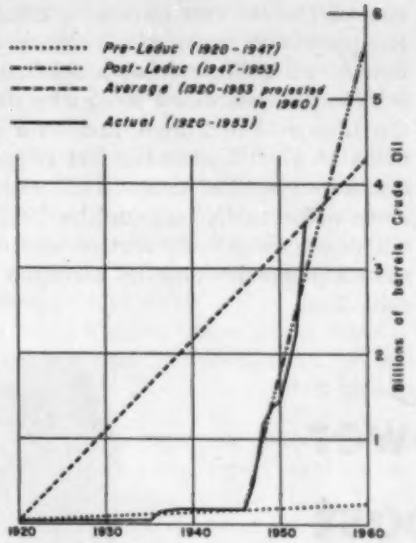


Fig. 1—Rate of cumulative discoveries.

Nevertheless, more oil and gas reserves from these other basins will be added to Canada's total. Likewise, if, as, and when Canada's oil reserves have been depleted and others made unavailable to such an extent that the price per barrel is so high that mining and extraction of oil from the tar sands of the Athabaska in Alberta is a profitable proposition, these reserves will then come into their own, and naturally add a tremendous amount to Canada's future oil reserves. Until that takes place the tar sands oil cannot justifiably be classed in the category of "proven undeveloped oil reserves."

Returning now to the Great Plains area of the west, and a look into their future, one cannot help but notice a similarity between "guestimating" the oil reserves of a newly discovered field or pool after completion of the discovery well. The first guesses are invariably too high. After several holes, with some reasonably long stepouts have been completed, the scientific estimates begin on the basis of the volumetric method which involves porosity, permeability, thickness of pay, areal extent of the field and the dangerous "percentage of recovery" factor. Here again the estimates are still on the optimistic side, and remain so until a greater number of holes have been drilled which includes some which are just plain failures, and others "not so good." At this stage the self-styled "conservative" estimators step forth, and slash the reserve estimates to an alarmingly low figure.

Preliminary and apparently alarming pressure decline data usually add fuel to their fire of pessimism. Prices for proven acreage are supposed to drop—and usually do, so that there is a change of ownership on a large scale in the field in question. However, as time goes on and the field or pool is drilled up, other pay horizons are quite often found, the field begins to extend a little more here and there with new stop-outs, etc., production decline curves become more reliable, the initial pressure decline is arrested, and it is generally conceded that although the first optimistic figures were too high, the first computations, based upon scientific reservoir data, were also too low.

This same sort of history applies to national and world petroleum and natural gas reserve figures. When oil was first discovered in large amounts in the U. S. no one dreamed that such oil and gas reserves were expendable, and it was generally understood that the country would always have a plenty. However, some 30 to 40 years ago a group of experts began calculating the oil reserves for the U. S. and came up with a figure of seven years' supply left in the ground. That was quite a shock, and oil geologists then came into their own. (Not as reserve estimators, but for oil exploration.) More oil had to be found. It was found, but every once in a while there was over-production and there resulted a slack in exploratory effort. After each slack period of exploration the reserves graph showed a decided lowering in rate of climb. Now the attitude is that the reserves are not inexhaustible, they are not alarmingly inadequate, but that for some time to come they will suffice if the necessary effort to look for more oil and gas is put forth.

Prospects good. In view of the fact that the number of exploratory holes drilled per acre in the Western Canada sedimentary basin area is far below that in the U. S., it's reasonable to believe that this Canadian area has better prospects for more discoveries in the future. Certainly the Canadian discovery rate of the last seven years will not be maintained uninterruptedly, but it ought to be somewhere between the pre-Leduc and the post-Leduc rate. The same applies to the natural gas reserves. Such being the case, the undersigned sees no need of considering all the sedimentary basin areas in Canada nor the tar sands oil, in order to feel optimistic about Canada's future oil and gas reserves.

The Western Interior basin area is large enough and results obtained to date warrant a geat deal more exploratory effort, and this should result in an increase of oil and gas reserves sufficient to "keep the wolf from the door" for some time to come. If the discovery rate for a period of 1 or 2, or even 3 years, does not measure up to the results of the best one of the last seven years there is no need for alarm, such as one occasionally reads in newspapers, when for an example, the discovery rate for January of 1953 was not as good as that of January, 1952 or 1947. Such comparisons are usually propaganda

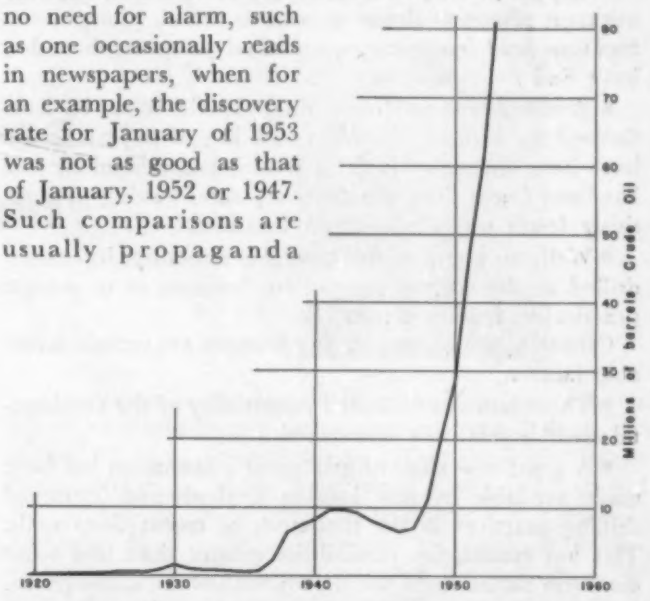


Fig. 2—Yearly production of Western Canada.

and very misleading, and the same applies to the same method if applied for extreme optimistic purposes.

To summarize, it appears that oil and gas reserves to be discovered in the future within the Dominion of Canada are such that the country will soon produce enough to meet all of its own requirements, and that a considerable amount will be available for export for some time to come. As a comparison one might say that the oil industry in Western Canada is at a stage comparable to that of the U. S. some 20 years ago, and that the resulting industrial expansion related to petroleum and natural gas reserves should be comparable. A conservative projection of the graph showing cumulative production of oil indicates that a minimum of approximately 4 billion barrels of oil should be discovered by 1960 in the Interior Plains area, and on a similar basis a minimum of 17 trillion cubic feet of gas should have been discovered by that time. In all probability, a great deal more will actually be found by 1960, and eventually the oil reserves will be in tens of billions barrels and corresponding gas reserves in multiples of tens of trillions cubic feet.

Added Oil From the Lower Mid-Continent, Gulf Coast

By ED. W. OWEN, Geologist, L. H. Wentz, Oil Division

THE LOWER MID-CONTINENT and Gulf Coast districts, comprising Southeast New Mexico, Texas, South Arkansas, Louisiana, Mississippi, Alabama, and Florida, contain 69 percent of the nation's proved oil reserves and furnish 61 percent of current production. Present productive capacity exceeds allowable production in several major fields and should continue to do so for the next few years. Since reserves and productive capacity are still increasing consistently, this prolific area should contribute a large part of the United States total supply for many years. However, limitations to the ultimate amount are becoming apparent.

The following considerations are fundamental to a discussion of future prospects.

- A major part of the total oil finding effort of the U. S. has been concentrated in this area for many years. Almost every square mile has been covered several times by the various geological and geophysical techniques.
- Capital and equipment have been available for drilling most prospects almost as soon as found. Many operators now hold fewer known undrilled prospects than they have had for many years.
- Economic conditions since World War II have favored the drilling of wells, which in earlier years would have been unprofitable. The resulting development rate has been faster than the discovery rate, leaving progressively fewer undrilled proven locations.
- Wells on many of the favorable structures have been drilled to the deepest prospective horizons or to present practicable drilling depths.

Offsetting these discouraging features are certain favorable factors.

- The enormous indicated potentiality of the continental shelf is relatively untouched.
- A great new store of geological information has been made available by new logging methods and improved drilling practices in the thousands of recent deep wells. This has cumulative possibilities greater than any other discovery factor since the introduction of the seismograph.
- New concepts of oil accumulation and occurrence increased the scope of exploratory efforts.
- Improved engineering practices, especially in pressure maintenance and secondary recovery, afford greater ultimate yields from both new and old fields.
- Increased utilization of natural gas liquids and more efficient processing add large reserves which were formerly neglected.

The geologist's ideas of future enterprises are unrealistic unless expressed in concrete terms. The writer, therefore, ventures to put a quantitative tag on his guesses regarding possible future sources of oil. These quantities, expressed in billions of barrels of ultimate recovery, are presented only as his personal opinion of the general order of magnitude for each of the categories under examination. They have no relationship to any official forecasts which have been made by industry committees or governmental agencies. Without other excuses, he postulates a lower-upper range, as follows:

1. Begin with the only solid figure in the whole lot—the proven reserves as of January 1, 1954..... **24 billion**

2. Future revision of reserve estimates of present fields in the light of further development will add ..... **3-5 billion**

3. Gulf Continental Shelf: Costly operations here will be highly sensitive to economic conditions. Under favorable circumstances, add..... **5-10 billion**

4. Deeper drilling on present producing structures: Although deep drilling has been general throughout the area, many large structures have been inadequately tested at depth. In West Texas and New Mexico, lower Permian and Pre-Permian beds are still partly, or wholly, unexplored on several important structures.

Recent discovery of flush Cambrian production in West Central Texas will introduce an active exploratory campaign, and some new oil will be found. It is not yet known whether this oil accumulated as a result of unusual local conditions, or whether Cambrian oil may be rather general.

Potentiality of pre-Edwards Lower Cretaceous and Jurassic formations in the Fault Zone is practically un-

known, although the few deep tests have been discouraging. New discoveries in these formations continue to be made in East Texas, North Louisiana, South Arkansas and Mississippi, and add modest amounts to existing reserves.

In the Gulf Coast provinces, deeper drilling activities are limited only by lack of known objective horizons having tangible economic promise. With thousands of feet of sedimentary section remaining unexplored, it is inconceivable that discoveries will not be made at greater depths in many of the present fields.

Taking everything into consideration, it seems reasonable to assign to future deeper discoveries on present known structures a value of.....**4-8 billion**

5. Stratigraphic Traps: "Stratigraphic trap" oil has always been difficult to find by planned exploration, partly because prospecting programs have been based firmly on concepts of local structure. Most discoveries of this type have resulted indirectly from structural prospecting or from haphazard wildcatting. Our realization that oil is a much more common constituent of sedimentary rocks than we used to believe, will intensify exploration for stratigraphic traps. We are only beginning to have really effective tools for the search, the high quality logs of thousands of recent wells which enable individual members of the geologic column to be traced accurately over wide areas. Regional and intensive stratigraphic studies should examine every porous zone to its permeability boundaries.

The truncated or depositional edges of many formations on the sides of the Central Basin Platform, Concho Arch, Matador Arch, and all other major positive features have vast potentialities. Many reef areas are only partially explored. The updip edges of many sands along the flanks of the Delaware and Midland Basins and major segments of the Gulf Embayment must be considered as possibilities.

These abundant stratigraphic traps will probably be our greatest source of future discoveries. Assume a widely ranging value of.....**5-15 billion**

6. New Structures: Undeveloped deep parts of our major basins undoubtedly have important local structures which we have not been able to work satisfactorily. Many other areas have been characterized by poor seismograph records and a paucity of other structural information. Improved geophysical techniques and more effective collaboration between geologists and geophysicists can be expected to uncover many favorable prospects. Let's give them.....**3-6 billion**

7. New Provinces: The Big Bend area of Texas, large parts of the "Rio Grande Embayment," coastal Mississippi, the "Florida Parishes" of Louisiana, and all of Alabama and Florida are still relatively untested. Some oil is there and more should be. We'll guess about.**2-4 billion**

8. Extraction of natural gas liquids has increased phenomenally in recent years, but some substantial sources of gas are not yet being utilized. Gas-distillate fields should constitute a very important part of future discoveries. From non-oil-associated gas, not included in reserve figures or in the guesses above, add.....**3-5 billion**

9. Ten percent of our gross production is from stripper and marginal wells, and thousands of new small wells are being drilled each year. Reserve estimates are based on the past experience record of early abandonment of such production. If improved economic conditions of the industry, the depletion allowance, and the availability of pipe can be maintained consistently, the supply of stripper and secondary recovery oil will be greatly increased. Add a hopeful.....**2-4 billion**

Summary: The minimum speculative increment exceeds the total proved reserves, which are slightly greater than the cumulative production to date. The combined proved and postulated supply under the lower guess would equal 32 years production at the 1953 rate, or 50 years at the higher estimate. It is believed that the higher figure is attainable only under consistently favorable economic conditions which stimulate energetic exploration.

Gas supplies should follow a similar discovery pattern, but are harder to appraise, due to wide variations in price, working pressures, and utilization practices. Lack of sound historical statistics on actual supply precludes realistic estimates of the future.

Discovery Prospects Good In Rocky Mountain Area

By CHARLES W. STERNBERG, Consulting Geologist, Denver

THE ROCKY MOUNTAIN province is an attractive area for discovery of future oil and gas reserves. The region covers more than 750,000 square miles, and embraces Colorado, Idaho, Montana, Western Nebraska, Northern New Mexico, North Dakota, South Dakota, Utah, and Wyoming. Arizona and Nevada, which are frequently considered to be part of the Rocky Mountain Province, are not discussed here.

The region is the largest single area in this country where presently known techniques will realize the possibilities for large future reserves. Throughout the Rocky Mountain states, there have been fewer wells drilled than in the East Texas field. New discoveries in the past few years have indicated enormous potentialities. Exploration, production, transportation, refining, and consumption have increased markedly, and will continue to do so

in the future. A greatly expanded level of exploratory activity is a most promising development.

The region has produced oil since 1862, when the first discovery was made at Canon City, Colo. In Wyoming, the Dallas field was discovered in 1883; it also is still producing oil. Little is known concerning early oil developments in Montana, but production was established by 1916. The earliest oil production in Northern New Mexico was obtained in 1922 in the Hogback field.

Utah discovery. Utah had its first real commercial discovery in 1948, and Western Nebraska in 1949. The Dakotas had previously produced some gas, and during 1951, North Dakota became an oil-producing state when oil was discovered on the Nesson Anticline. South Dakota became the twenty-eighth oil-producing state early in 1954. As yet there has been no production in the state of Idaho.

In spite of this long history of production, the Rocky Mountain Province has been relatively neglected. The reason for this is chiefly that the oil could not always successfully compete with crude produced in other parts of the country. The local market has been a limited one. There is, however, a trend of population westward, and this trend is expected to increase. Oils in the region range in gravity from 75° to 11° and vary in color from clear to black. Some have pour points higher than 90° F., others are still liquid at —50° F. The sulfur content varies from a trace to more than four percent. Both oil and gas reserves are known throughout the province.

In the Uinta Basin, many asphaltic substances such as gilsonite, ozokerite, and wurtzilite are found, and there is enormous tonnage of oil saturated sandstones in this basin. The oil shales are an important future factor in the petroleum industry, and the Green River formation of Eocene age is the chief source of oil from shale. Proved reserves are stated to be in excess of 60 billion barrels. Carbon dioxide and helium occur at many places throughout the region.

Drilling depths range from a few hundred to thousands of feet. The West Poison Spider field produces from a depth of 14,400 feet, and for a time, was the deepest producing field in the world.

On the West the Rocky Mountain area lies in the great Cordilleran Geosyncline and more particularly in an eastern area of subsidence, the Rocky Mountain trough. This trough received enormous thicknesses of sandstones, shales and limestones, which are not metamorphosed. A general boundary may be drawn along the North-South zones of faulting which define the eastern limit of the Basin and Range province. The rest of the Rocky Mountain region is a shelf area between the Canadian Shield and other positive features and the Cordilleran Geosyncline. These shelf areas received thin deposits of sediments from widespread shallow seas. Various tectonic events—for example the Ancestral Rockies—influenced and modified this pattern.

Oil seeps occur in outcrops of pre-Cambrian rocks in widely separated localities. The Cambrian and the Ordovician produce oil. Silurian beds are missing in parts of the Rocky Mountain area, but are present and productive in the Williston Basin. The Devonian produces in the Williston Basin, and it is a future objective in other parts of the Rocky Mountain province.

The Madison limestone (of Mississippian age) is the oldest proved commercial zone in much of the area, and the Big Snowy group, which is also Mississippian, while limited in distribution, is a worthwhile objective. Most of the Pennsylvanian oil comes from the Tensleep, and its equivalents, the Weber and the Minnelusa. The Embar is a producing formation in Wyoming, the Lyons sand produces in the Denver-Cheyenne Basin, and the Coconino sandstone, which is also Permian in age, produces in southeastern Utah.

Triassic beds produce in Wyoming and in Colorado. The Ellis and the Sundance which are middle Jurassic in age, produce large amounts of oil and constitute a first-class objective over much of the territory. Cretaceous sandstones are the most widespread oil and gas zones in the region. Eocene oil has been found in the Green River and Uinta basins.

From the beginning of the Paleozoic into the Tertiary, all major periods of geological time are proved producers of commercial amounts of hydrocarbons.

In Montana, positive elements have influenced accumulation in the Sweetgrass Arch and Big Snowy areas. In other parts of the state, negative elements are most important. The Williston Basin, a major sedimentary basin which lies partly in Montana, but which also extends into North and South Dakota, and into Canada, covers almost 120,000 square miles. It is an important producing area, and will increase in importance.

In Wyoming, most of the oil and gas fields have been found on the rims of structural basins (Baxter Basin is a prominent exception). In Colorado, there are important fields in the northwestern part of the state, but the greatest present activity is in the Denver-Cheyenne Basin. While many fields have been found in this basin, many more remain to be discovered, and pre-Cretaceous possibilities are as yet largely unexplored. Western Nebraska is a part of the Denver-Cheyenne Basin.

In Utah, the northeastern part of the state is the primary producing area, but significant shows in the southern portion of the state have been of considerable interest. In Northern New Mexico, all the oil and most of the gas fields are in the San Juan Basin, one of the world's major gas areas. Gas, which is rich in carbon dioxide, has been found in Northeastern New Mexico.

There are areas of merit in all of the states of the Rocky Mountain province. More important than in other regions, however, are the economic factors. Transportation of crude to other markets is still a problem. New pipe lines have been constructed; others are now in various stages of completion; still others are under consideration. Market demands are being met by additions to existing refineries and by new construction.

The outlook for future discoveries is indeed bright; there are important and sizable areas which have had virtually no exploration; and conditions are such that the future will lead to a marked increase in total reserves. In general, over the next few years, the various oil producing areas will maintain the same relative positions, but there will tend to be a shift of emphasis toward limits of the territory.

Upper Mid-Continent Can Increase Discovery Rate

By **PAUL L. LYONS,** Anchor Petroleum Company, Tulsa

THE UPPER MID-CONTINENT, consisting of Oklahoma, Kansas, and Illinois, and including Iowa and Missouri, presents prospects for oil and gas discoveries sufficient to sustain and even increase its production of oil and gas in the next twenty years, assuming a favorable economic climate.

This conclusion is warranted, statistically, by a consideration of the production of oil in the three important states by ten-year periods.

	Oklahoma	Kansas	Illinois	Total
	(Production in millions of barrels)			
1904-13	388	23	210	621
1914-23	1104	264	139	1507
1924-33	2038	385	68	2491
1934-43	1706	702	604	3012
1944-53	1586	1055	665	3306

The rate of increase is not as great as that of the population, and therefore an increased production rate and discovery rate is called for. The discoveries to be expected include, of course, a great host of "bread and butter" discoveries, including small pools, extensions, additional productive horizons in pools, etc. But a number of major field discoveries are necessary, and these fields, usually found in newly developing areas, must bear the major burden of production.

Sufficient large areas, under which there are undeveloped geological sections, exist in the upper Mid-Continent district to merit optimism concerning the discovery of a number of major pools in the next twenty years, provided that advanced exploration techniques and determined drilling are brought to bear on the problem. The district contains quite a high proportion of proven but only partially developed areas which may be expected to provide a sizable number of moderate sized pools. The law of diminishing returns applies to many of the heavily drilled areas of the district, but it is difficult to state just when an area is fully developed and not likely to provide significant additional production. Certainly dense drilling serves to define the structural and stratigraphic conditions of an area to the extent that more intelligent and accurate drilling locations may be made. As drilling increases, however, the size of pools found diminishes as they are restricted by dry holes.

In certain parts of all three states the drilling is so dense that certain areas may be said to be developed at least as far as the drill has penetrated in developed horizons. Even in these areas, however, the advent of "fracing" and secondary recovery techniques serves to lend a new impetus to drilling and production, so that these very areas will still provide substantial production during the next twenty years.

The most favorable areas for oil and gas in the upper Mid-Continent were developed, or partially developed, during the last fifty years of drilling. But perhaps an equal number of favorable areas remain to be exploited, and the modern more rapid drilling and exploitation rates will serve to put the finds quickly into the production column. This will serve to offset the less favorable prospects of the remaining virgin areas as compared with the slowly developed favorable areas already exploited. That is, we can develop areas in twenty years which formerly took fifty years.

The areas of the upper Mid-Continent awaiting full exploitation are listed here by their geological or geographical descriptions, and roughly in the order of their favorability and desirability from an exploration standpoint. Desirability enters the picture, because it must be possible to explore an area well and drill it at reasonable cost to make it attractive to operators. Of the areas listed, the first ten offer the best possibilities for the finding of large volumes of oil and gas. The remaining four are not out of the picture entirely, and should be regarded as "dark horses."

1. Ardmore Basin Extensions (Oklahoma)
2. Anadarko Basin (Oklahoma)
3. Oklahoma Panhandle-SW Kansas
4. Western Kansas
5. Salina Basin (Kansas)
6. Central and SW Illinois
7. NE Flank Arbuckle Mts. (Oklahoma)
8. Palo Duro Basin (Oklahoma)
9. Forrest City Basin (Kansas)
10. McAlester Basin (Oklahoma)
11. Ouachita Mts. (Oklahoma)
12. Extreme SE Oklahoma
13. NW Flank of Ozarks (Missouri)
14. Iowa

Expectations of these areas may be summarized as follows:

Ardmore Basin Extensions. Fabulous reserves have been established in the last five years in the Velma area of Oklahoma's Ardmore basin. The basin extends both to the northwest and southeast of the area of intensive development in the sandstones of the Deese and Springer formations. There is every reason to beleive that additional finds in both directions will be made where the objective formations are present.

Anadarko Basin. This vast basin is almost certain to yield a number of major accumulations as well as a goodly number of moderate sized pools. This is indicated by the sizable reserves of the large Elk City pool, near the deepest part of the basin, and by recent discoveries in widely separated Custer and Woods counties, as well

as by the stratigraphic accumulation in the Ringwood pool of Major County. All the usual productive horizons of Oklahoma are favorable for production, including the Chester section.

Oklahoma Panhandle-Southwest Kansas. The areas east and west of the Hugoton gas field offer great promise for both oil and gas development in multiple Pennsylvanian horizons and in the Permian near Hugoton itself. Immediately east of the Hugoton field, 37 oil and gas pools have been discovered in the last three years. West of Hugoton, 5 oil and gas pools have been found in the same length of time, including the obviously huge Greenwood gas field of Kansas and Oklahoma. Widespread extent of accumulations is indicated by the stratigraphic character of many of the traps.

Western Kansas. Western Kansas will provide many a small pool, perhaps a few large ones. Successive truncation of the Mississippian section on the west flank of the Barton arch has led to high hopes on the part of operators that the porous conditions in the truncated Arbuckle on the uplift with accompanying production will be repeated in the Mississippian limestones over vast areas of western Kansas. In the extreme western part of the state, Pennsylvanian limestones grade into sandstones, promising stratigraphic trap type accumulations if oil and gas are present.

Salina Basin. Potential site of many pools is the sparsely drilled Salina basin of Kansas. The sedimentary section, not unlike that of the remainder of Kansas, does not justify the avoidance oil men have given it. Porous Pennsylvanian limestones and sandstones, the Hunton, Trenton, Simpson, and Arbuckle are present at shallow depths.

The Salina basin is at present in much the same status as was the Denver basin several years ago. Seismic reflections are deceptively good, and several majors have given the basin a once-over-easy reconnaissance survey and have drilled what they considered to be prominent seismic anomalies. The same could also be said of the Denver basin prior to the oil discovery at Gurley, Nebraska.

Central and Southwest Illinois. The shallowness of the productive Chester section in the deep part of the Illinois-Indian basin has invited the drilling of so many thousands of wells that the law of diminishing returns has been operating for those formations. This dense drilling applies mostly to the Pennsylvanian and Chester sections, and, by contrast, the pre-Chester Mississippian, Devonian, and Silurian sections are somewhat sparsely drilled, and the Ordovician is very sparsely drilled.

Northeast Flank of Arbuckle Mountains. This favorable prospective area extends from the Fitts pool of Pontotoc County, Oklahoma, southeastward to the Oklahoma-Texas line. A portion of it lies beneath the Choctaw overthrust. The section is very favorable, the exploration is difficult.

Palo Duro Basin. The sedimentary section is fairly favorable, rather deep. The Strawn section looks good, and some reefing may be present in Pennsylvanian limestones. Oil and gas are present, but occurrences are hard to pinpoint.

Forrest City Basin. This basin will furnish a modest yield of oil pools. Nature has made it a tough nut to crack, and it is difficult to find a closed structure in a desired producing horizon because of unconformities and sedimentary variations. A favorable section is present, and oil, although not prolific, is certainly there for the keen and observant students of geology and seismology.

McAlester Basin. The high fixed carbon ratio has for years been held against this basin. With the exception of some shallow sands, much of the favorable section is rather deep, and the percentage of shale in the section increases greatly basinward at the expense of the sandstones. In recent years, rather general leasing activity through the basin indicates a sustained search for additional oil and gas, with the emphasis on the latter.

Ouachita Mountains. There are oil seeps in this province, and there are few shallow, inconsequential oil and gas pools. Some of the earliest geological exploration in Oklahoma occurred here, because the area looked favorable, at least structurally. Interest at present is focused on the possibility that high structural elements of Arbuckle type facies are present in places under the masking thrust sheets and are responsible for the seeps. The thrust sheets in themselves offer little promise.

Extreme Southeast Oklahoma. It is possible some sort of faulted extension of the Arbuckle Mountains may exist here, buried beneath Cretaceous rocks and the thrust sheets of the Ouachitas. A prominent gravity high and earthquake activity lend support to this wild speculation.

Northwest Flank of Ozarks. Extreme western Missouri has produced some gas, and there are some plans afoot for oil mining in outcropping rocks in this part of the state. Invasion by fresh water of the porous rocks of the sedimentary section in the northern part of Missouri has caused the majority of observers to regard the possible oil and gas traps as "flushed." The many water wells drilled without shows of oil and gas lend support to the conclusion that the hydrocarbons are gone.

Iowa. It is extremely strange that to this vast area the same statements apply as hold for northern Missouri. Some faint hope may be held for oil and gas accumulation in some Devonian sandstones present in the subsurface and in buried Silurian and Devonian reefs expected to be present.

To summarize, it is a difficult statement to make, but it would seem to be possible, from the geological data, that the rate of finding oil and gas reserves in the upper Mid-Continent district can be increased as much as necessary for perhaps 20 years. But to do this, the number of wells drilled in the area must be increased, and the depth of wells drilled must be increased. To bring about a realization of this, the incentive for such a drilling program must also be increased. —**The End**

IT WILL PAY YOU to look into the economies of operating an old pump. New pumps like this require less maintenance and power.

When to Replace a Pump?

Check the hidden costs. They may run higher than the cost of a modern replacement.

By C. E. CROMWELL, DeLaval Steam Turbine Company, Trenton, N. J.

DIGGING INTO the economics of operating an old pump could turn up highly profitable information. The appearance of satisfactory performance may be hiding real costs which could very well represent the price of a modern pump, and other appreciable savings, too.

A pump may still be delivering designed capacity and head despite its age. It is this fact, the seemingly satisfactory performance of the pump, that protects its reputation as an "old faithful" from closer scrutiny. Gradual decreasing efficiency is not as noticeable as a sudden breakdown. Nor are power costs looked upon as excessive unless totaled up over a number of years and compared with similar costs for a new pump. Pump manufacturers have come a long way in designing units to reduce over-all operating costs.

Consider a motor-driven pump built in 1928 to handle 2500 gallons per minute against 150 feet total head. When originally built, it had an efficiency of 78 percent requiring an input of 121 brake horsepower. Due to wear and tear, and if no revolving parts have been replaced, it could be expected that the pump in 1953 would have an efficiency of about 74 percent, and would require 128 bhp to deliver the designed capacity and head.

Save 18 bhp. A modern pump for these same conditions could be expected to have an efficiency of 78 percent, requiring 110 bhp. This is a possible saving of 18 bhp. Based on a power cost of 1 cent per kilowatt-hour, savings in power cost for one year (8760 operating-hours) is $1176.

The cost of a new pump or complete unit, and the time it would take to pay for it from the operating-savings gained over old pump are shown here. The following figures are based on 1 cent per kwh, or $.00746 per horsepower. (Add additional costs for freightage and for changing foundation and piping to the total cost figure.)

Price (estimated) of new pump, base, coupling	$1238
Price (estimated) of 125-hp 440-v 1750-rpm motor	1390
Price (estimated) of reduced voltage starter	1170
Total cost of new pump, motor, starter	$3798

Hours per year operation	8760	6500	4000
Savings will pay for pump, base and coupling in	13 mos.	17 mos.	28 mos.
Savings will pay for complete unit in	39 mos.	52 mos.	84 mos.

Even if renewal parts for the 1928 pump could restore its original efficiency of 78 percent it still requires 11 hp more than the new pump. Based on 8760-hour operation per year, power cost of old unit is $719 more. Depending on how obsolete the pump parts are, they might be relatively expensive, compared with the cost of a modern pump.

If the amount saved each year on power cost were set aside to accumulate interest, the total will then represent an amount that will pay for all or

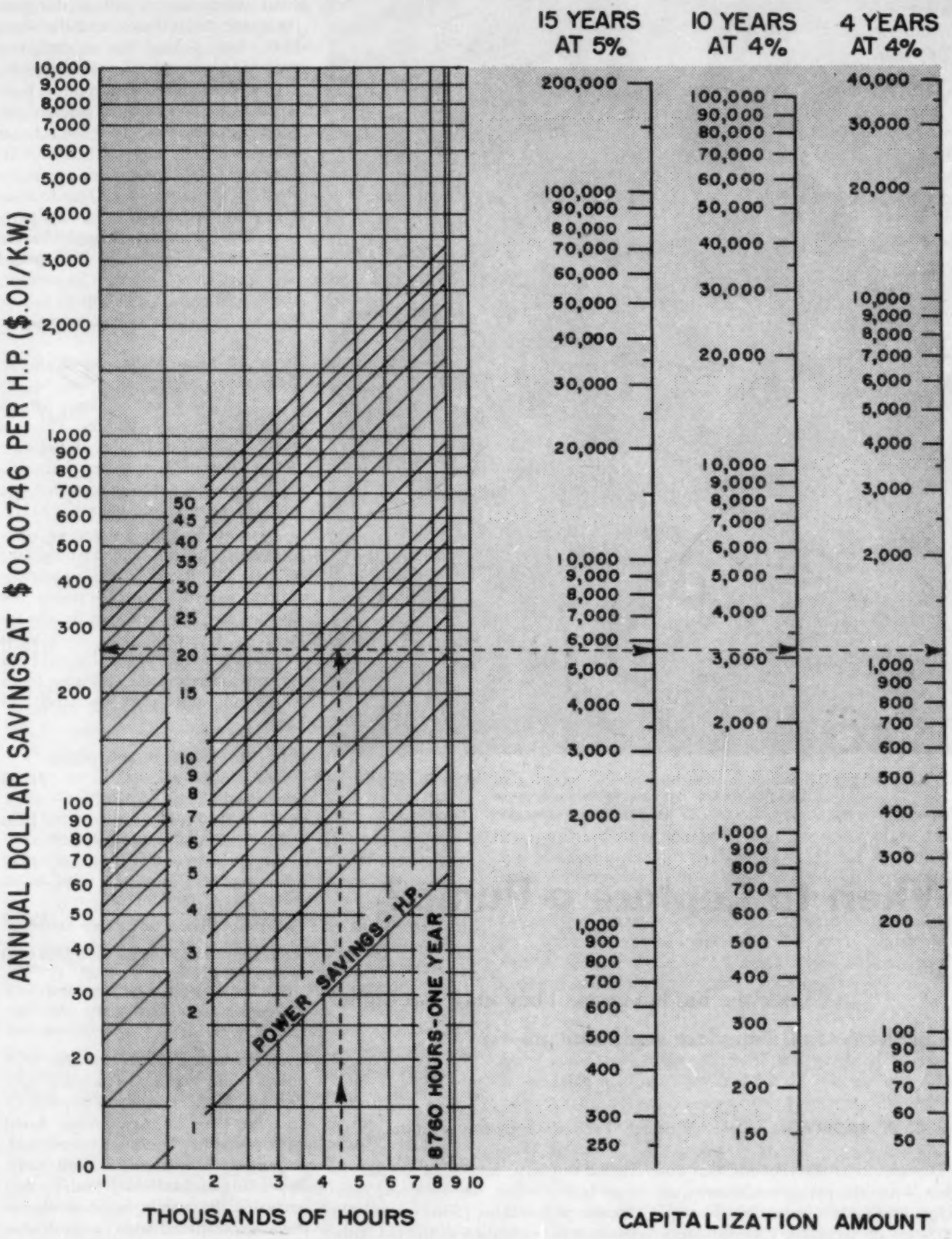

15 YEARS AT 5%
10 YEARS AT 4%
4 YEARS AT 4%
ANNUAL DOLLAR SAVINGS AT $0.00746 PER H.P. ($.01/K.W.)
POWER SAVINGS - HP.
8760 HOURS-ONE YEAR
THOUSANDS OF HOURS
CAPITALIZATION AMOUNT

FIGURE. 1

HOW TO USE THE CHART. Here is an example plotted on the chart. A 1930 model pump has an efficiency of 71.7 percent requiring 100-horsepower motor. A 1954 pump has an efficiency of 78 percent requiring only 92-hp motor. Savings is 8 hp. The pump operates about 4400 hours per year. Find the point where diagonal 8-hp line intersections 4400-hour line. Column at left shows annual saving to be appoximately $260. The saving in ten years (considering interest at 4 percent compounded annually) would be about $3200.

part of the cost of a new unit. If a company's practice is to consider relatively long term write-offs, these savings may well be sufficient to pay for the new unit and also for other additional capital expenditures.

Some operators of central-station power plants believe that in a new station a unit that pays for itself in eight to ten years is a good investment. When replacing old equipment, the expected life of the plant may reduce the length of write-off that can be considered. This premise must be considered throughout industry, regardless of the products.

Calculating Savings. Calculation of power cost savings and capitalization amounts can be made quickly by using the chart in Figure 1. First compute the horsepower savings and multiply the results by yearly hours of operation. This chart can be used for quick approximations and can be read within about 2 percent accuracy.

The diagonal lines represent "horsepower savings." The abscissa shows "hours per year" of operation. Reading vertically up the "hours per year" to the "horsepower savings," to the left ordinate is the "annual savings" in power cost, and to the right ordinate is the "capitalization amount." Shown are three right hand ordinates, each for different interest rates and terms of years.

The chart is based on cost of power at $.01 per kilowatt. If in a particular locality power cost is more or less, simply multiply answer from the chart by the ratio to actual cost; i.e., if the cost is 12 mils per KW, multiply by 1.2; if the cost is 9 mils per KW, multiply by .9.

Examples of Savings. The following examples are taken from records to show what improvements in efficiency have been made and the saving and capitalization amounts are taken from the attached chart.

1. **Service Water Pump.** Consider a pump installed in 1926 having an efficiency of 70 percent and an input of 28.9 bhp. A modern pump for the same conditions (400 gpm, 200 feet total head) has an efficiency of 79 percent and an input of 25.6 bhp. This is a 3.3 bhp saving. Annual saving if service water pump runs 6000 hours per year is $150. Capitalized in four years at 4 percent interest the total amount is $630. The estimated price of a new pump for these operating conditions is $438.
2. **Boiler Feed Pump.** 400 gpm, 650 total head at 220 F.

year 1930, efficiency 63 percent, 99.5 bhp
year 1953, efficiency 69 percent, 91.0 bhp
8.5 bhp saving

Annual saving if pump operated 8760 hours per year is $560. Annual savings capitalized in 10 years at 4 percent represents a total of $6700. Estimated cost of new pump is $1101.

3. **Water Works Pump.** 15 mgd (10,400 gpm), total head—200 feet.

year 1926, efficiency 84 percent, 625 bhp
year 1953, efficiency 89 percent, 590 bhp
35 bhp saving

Annual saving if pump operated 5000 hours per year is $1300. Annual savings capitalized in 15 years at 5 percent represents a total of $28,000. Estimated price of new pump is $4054.

TABLE 1
Annual savings divided by factors in table equals sum including interest accumulated for number of years and interest rate selected.

Years	Percent Interest Rate/Annum, Compounded Annually				
	2	3	4	5	6
2	.49505	.49261	.49020	.48780	.48544
3	.32675	.32353	.32035	.31721	.31411
4	.24262	.23903	.23549	.23201	.22859
6	.15853	.15460	.15076	.14702	.14336
8	.11651	.11236	.10853	.10472	.10104
10	.09133	.08723	.08329	.07950	.07587
12	.07456	.07046	.06655	.06283	.05928
15	.06260	.05377	.04994	.04634	.04296

About the Author

CLYDE E. CROMWELL, manager of Commercial Sales division of De Laval Steam Turbine Company, holds a B.S. degree in mechanical engineering from Rose Polytechnic Institute. He joined De Laval in 1937. He is a member of ASME, Engineers Club of Trenton, American Water Works Association, and Technical Association Pulp & Paper Industries.

When accurate calculations are dequired for formal presentation, annual savings are obtained by multiplying horsepower savings by yearly hours of operation x cost per horsepower hour (kwh cost x 0.746). The annual savings divided by a factor, based on terms of years of interest rate will give the capitalization amount. Table 1 lists these factors for various terms and interest rates. These can also be used for terms other than those shown in the chart.

Undoubtedly, plant engineers in industry and municipalities realize that the hidden costs of operating old equipment could very well represent the purchase price of new equipment. But management officials must be shown why the purchase of modern equipment is a wiser investment than the continuing costs of operating old equipment. In some cases, the actual cost factors of operating old equipment are obscured because power costs are negligible, where power is obtained as the byproduct of some process. Or the unit may be fully depreciated.

If power and depreciation are negligible factors, which is seldom the case, there are still repair costs of some kind to consider. Obsolete parts are more expensive and require extended delivery time. Should production losses occur because of the delay in obtaining obsolete renewal parts, the losses are chargeable to the old pump. The cost of modern renewal parts for which patterns are available and the parts are in stock represent very tangible savings when compared with the cost of obsolete parts. Sometimes a modern pump can be purchased at prices equal to or even less than the cost of extensive renewal parts for an old pump.

The chart and examples shown here could help engineers give management officials a graphic insight into economics of depreciation, deterioration and obsolescence for a particular installation in their plants. They will also show how the higher operating costs entailed by these three factors could be converted into appreciable savings to make modernization pay its own way. —**The End**

LAUNCHING BEGINS. Contractor Sammy Collins gives the "go" signal to control tower in background to start launching operations of the two-mile long, 12-inch sea-loading line in the Atlantic Ocean off British West Africa.

TUG OF WAR. And the natives won out over the rough waters of the Atlantic. Here they pull three-inch hawser into shore. The tug which pulled the pipe line through the rough surf could get no closer than 2500 feet from shore.

ACROSS THE SACRED LAGOON of Kawli Gona comes the first section of pipe on its way to the ocean. The lagoon is sacred to the Gold Coast natives and pipeliners had to receive a special concession from the High Priest to lay the pipe.

Primitive labor and modern technical know-how were combined on this job off the African Gold Coast to lay what is believed to be the . . .

World's Longest Sea-Loading Line

By DONALD M. TAYLOR, Editor, PIPE LINE INDUSTRY

PIPELINERS LAID a 12-inch pipe line through the rocky surf two miles out into the rough waters of the Atlantic Ocean off the Gold Coast Colony of British West Africa. As a result, tankers can now tie on to mooring buoys in 50-foot-deep water and pump gasoline and other products into Accra, capital of this mineral-rich colony. The 11,500-foot line was laid in February for Socony Vacuum Oil Company (Gold Coast Ltd.). It is believed to be the longest sea-loading line in the world.

Taylor-Woodrow, Ltd., one of England's foremost heavy construction companies, and Collins Construction Company, submarine pipe line specialists, joined forces to build the line. They constructed a launching site on shore, welded the pipe up into 1400 foot sections, and coated it with bitumastic and concrete. Then they spaced pontoons 100 feet apart along the line to give it buoyancy and pulled it into the sea with tugs. They welded the 1400-foot length of line together as they entered the water. When the line was in place, the pontoons were released and gathered in by small boats.

One of the remarkable features of the job was that only four days elapsed

NATIVES WRESTLE launching unit onto one of the 14 sand-filled cribs in the lagoon. They formed a human conveyor to transport sand from shore to cribs.

from the time the first joint entered the water until the project was finished.

But before the first foot of pipe could be pulled into the raging surf, many difficulties had to be overcome. First a route through the undersea rocks and boulders had to be found. Ed LeBoeuf, Collins field superintendent, solved this problem by combing the area, first with fathometer-equipped boats and then with divers.

Black magic. But difficulties still persisted. To use the route, they would have to launch pipe across Kawli Gona, a lagoon sacred to the natives who still believe in Juju, a religion founded on black magic and fetishes.

So one of the first tasks confronting the Collins crew, was to convince the high priest of Juju that pipe launching operations would not compromise the religious properties of the water. After lengthy negotiations which culminated with a ceremony in the lagoon, the pipeliners received a reluctant go-ahead and set about their work.

Crossing the lagoon. The lagoon is 400 feet wide. To launch the pipe, Collins had to have 14 platforms which could be used to support rubber-tired launching units. Engineers decided to use 8 by 10-foot timber cribs filled with sand. This is where the natives came in.

Under the direction of their foreman they constructed the cribs, and then formed an endless human conveyor to fill them with sand. They scooped sand from the beach into pans balanced on their heads and waded through the waist-deep lagoon to empty them into the fill.

Once the cribs were filled to proper height, the natives wrestled steel rails into place and slid the launching units into position on the "aerial" launchway.

But completion of this task was not the end of the human conveyor belt. From the lagoon the launchway had to cut through the natural barrier of volcanic ash and sand that fronts the ocean. About 200 feet from water's edge, it had to tunnel beneath one of the colony's main highways. Once again Taylor-Woodrow and Collins had to depend on native labor to make a portion of the excavations and to maintain them against the leveling action of the tides.

Work in pipe yard. While work on the launchway was going on, crews were busy welding the 12¾-inch pipe up into 1400-foot sections. American welders were used. Every weld was X-rayed. As each section was completed, it was double coated with bitumastic and fiber glass and then wrapped with reinforcing steel and gunited with concrete.

A one-inch coat of concrete was applied to all of the line except the 900 feet nearest the shore. Because of the constant pounding of the surf, this section of line was coated with 1½ inches of concrete.

After the concrete on all of the sections had been cured, pontoons were banded to the pipe (with steel bands similar to those on heavy packing cases) to lighten it as it was dragged out to sea. The pontoons were spaced about 100 feet apart to cut the negative buoyancy of the pipe from 11 to 14 pounds per foot to 1 to

CUTTING UNDERNEATH ROAD for pipe launchway. Natives used head pans to carry the sand away from the excavation site.

3 pounds per foot. To do this accurately, every joint of pipe was weighed after it had been coated with concrete.

Launching the pipe. In planning the job, Sammy Collins had elected to drag the pipe out to sea with two 1500-horsepower tugs. But because of the rough surf and shallow underwater boulders, the tugs could venture no closer than 2500 feet from shore. This meant that a heavy line capable of pulling two miles of pipe out to sea had to be brought in through the surf.

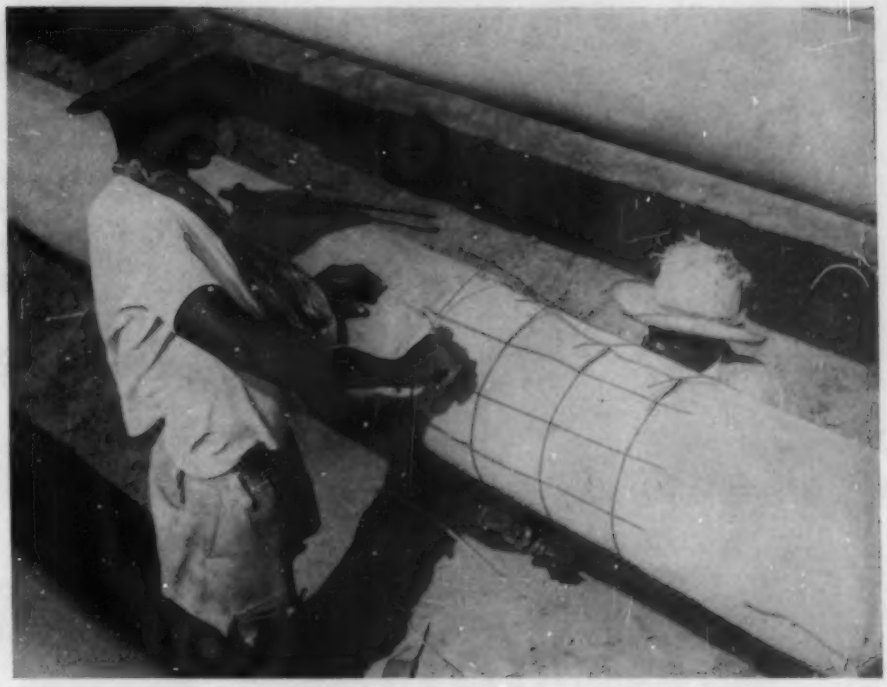
Once more, native labor played a key role. Because Accra has no harbor, ships have always had to be discharged while standing at sea. To accomplish this the natives use dugouts manned by 11 men—ten oarsmen and one cook.

It was one of these surf boat crews that dragged the three-inch-diameter manila hawser from the tug through the surf to shore. (A manila hawser was used rather than a wire rope because it would float until it became water-logged.)

Once the hawser was ashore and clamped to the pulling nose of the pipe, the first tug set about pulling it into the water. When the midway point was reached, a second tug was added and the pipe line was pulled to its final resting place.

The next operation was to release the pontoons which buoyed the pipe. Collins Construction Company has an ingenious way of doing this. The steel bands which hold the pipe and pontoons together can be readily severed by an upward tug on a patented releasing mechanism.

During launching each of these mechanisms has a manila line attached to it and by reeling up a one-half-inch wire rope which runs the length of the underwater pipe line, the ends of the manila lines can be brought to the surface. This permits the pontoons to be selectively released from the pipe.



REINFORCING STEEL in concrete ran from one end of the line to the other.

Mooring installation. Divers removed the flanged pulling nose from the pipe line and attached a high-pressure eight-inch rubber hose. This hose, which is equipped with a valve, is suspended in the water by a buoy which tankers take on deck when making the connection prior to discharge.

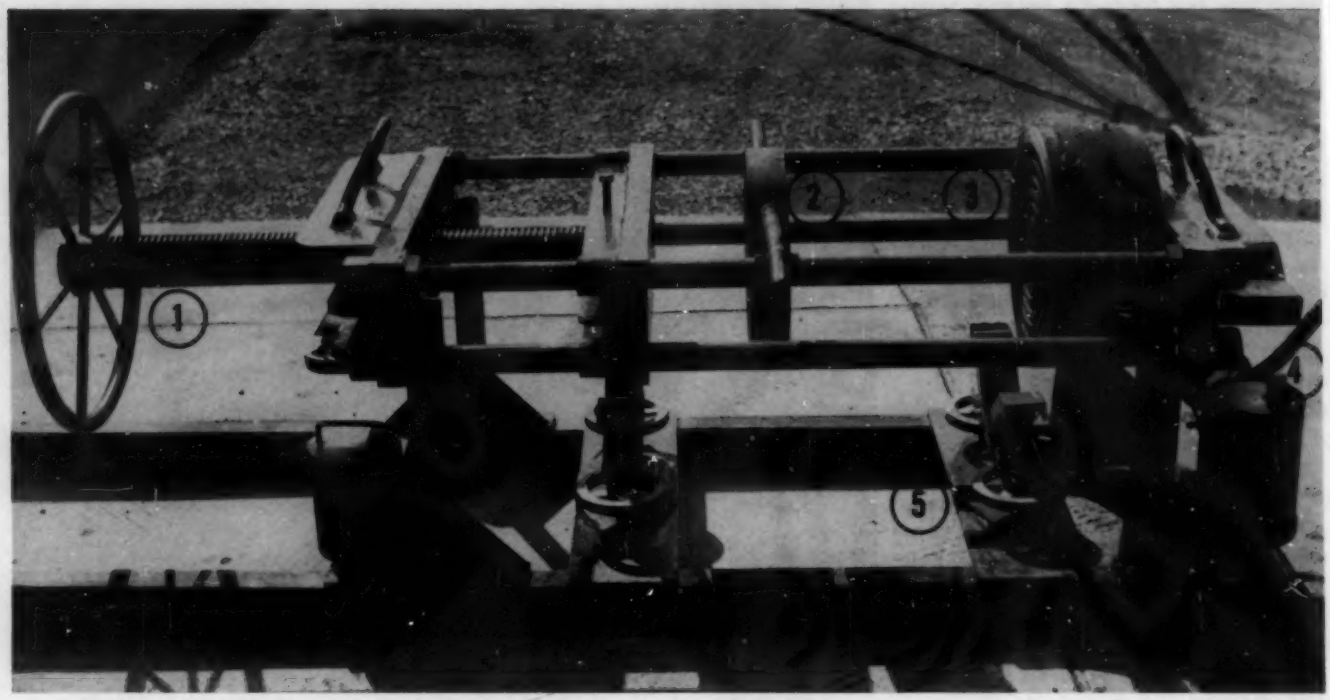
Personnel. Socony-Vacuum had two inspectors on the job. They were Warren L. Morris, chief inspector, and John Selby, inspector.

Taylor-Woodrow had five men on this job. They were John Guthrie, general manager, for West Africa; I. M. M. Buchanan, project manager; Frank Sheppard, general foreman; Tom Miles, master mechanic, and Jerry Finn, diver.

Collins Construction Company had 12 men on the job. They were Sammy Collins, owner; Billy Glasscock, general manager; Ed LeBoeuf, field superintendent; Walt McKinley, marine engineer; Sal Costa, engineer; Tom Broome, diver; Robert Glasson, X-ray technician; Frank Ernst, Jack Hale, submarine pipe line specialists; Ernie Landry, welding foreman, and Dale Kramer, Drew Herrington, welders.

—The End

FINAL WELD on the line. There was a time lapse of four hours between pulls.



THIS GATE VALVE TESTER tests all sizes of valves, from 4 to 12 inches. No. 1 shows handle which tightens head against valve. Nos. 2 and 3 are heads which fit flanges of valve. No. 4 is hydraulic ram which forces heads tightly against valve for tests. No. 5 is leveling block which supports valve. Air-operated pump not shown here is used to develop hydraulic pressure inside valves.

Shop-Made Valve Tester Solving Some Problems

Here's a company that tests all valves in the warehouse to prevent faulty ones from showing up on the job.

By CARL I. HUSS, Service Pipe Line Company, Tulsa

A HURRIED CALL came into Service Pipe Line's materials section in Tulsa. It was from a maintenance crew down in Texas and they needed a certain type and size gate valve pronto. The materials men looked at their records and saw that the Carrollton, Mo., warehouse had a second-hand valve of that type in stock. They phoned the division warehouseman at Carrollton and told him to ship the valve to the Texas crew at once.

The gate valve arrived at destination in a few days and the crew installed it. Then—they discovered the valve leaked. The job was delayed several days more while another valve was shipped.

Need Was There. This incident pointed up the need for testing, classifying and weeding out all defective second-hand gate valves in warehouse stock.

Why hadn't the valves been tested? The company has some 900 second-hand valves in stock and testing them the conventional way would have taken more manpower and time than were available.

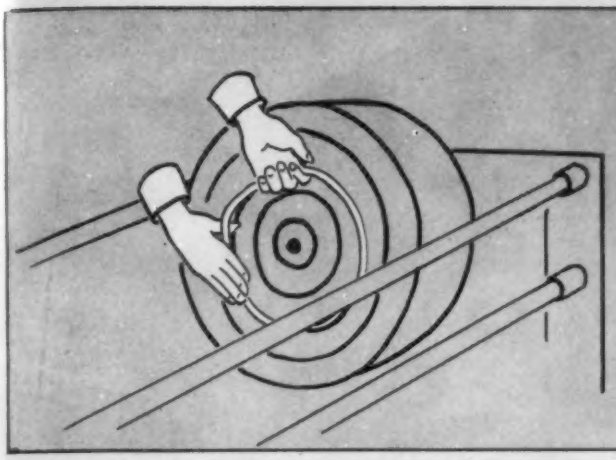
What Was Answer? Art Hill, superintendent of line maintenance, and Fred Zilm, welding technician, last year set out to find an answer. They decided to invent a machine, one that could be moved about from one location to another on a truck, one that could be operated by anybody in the maintenance crews after a little instruction, that could test different size valves and, most important, could test all parts of the valves in a short time at a reasonable cost.

After much study they drew up their blueprints and turned them over to Arlie Zumwalt, superintendent of the company's machine shop at Tulsa. They asked Arlie, a veteran machinist, to include any improvements he could think of. He added several refinements before turning the plans over to his machinists and welders who constructed the machine.

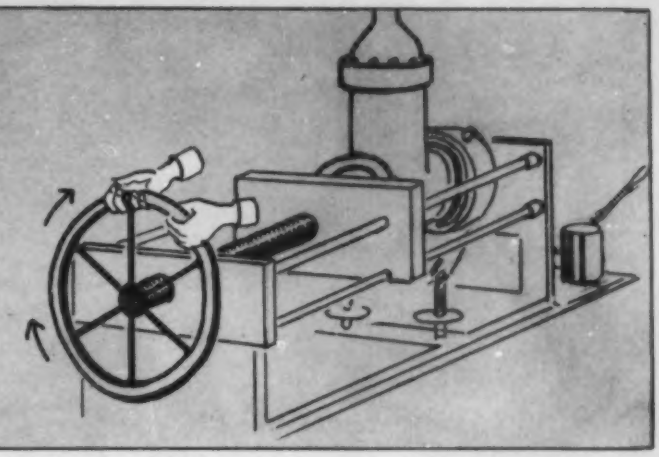
Several exhaustive tests showed where improvements in the machine could be made and after these were made the men were satisfied with their creation. The machine will test valves in all sizes from 4 to 12 inches, and is easily transported. It operates on tap water and compressed air, both available at warehouse locations.

How It Works. Briefly, here's how the gate valve tester works: The valve to be tested is first steam cleaned to remove scale, dirt and wax. The valve then is lifted into the machine by truck winch and centered into position by two adjustable "V" blocks.

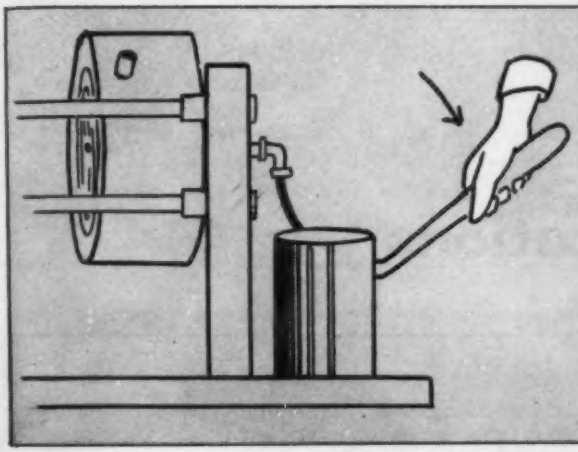
Pistons with grooved heads next are tightened against the valve flange faces, a water-tight fit being obtained by "O" ring rubber gaskets retained



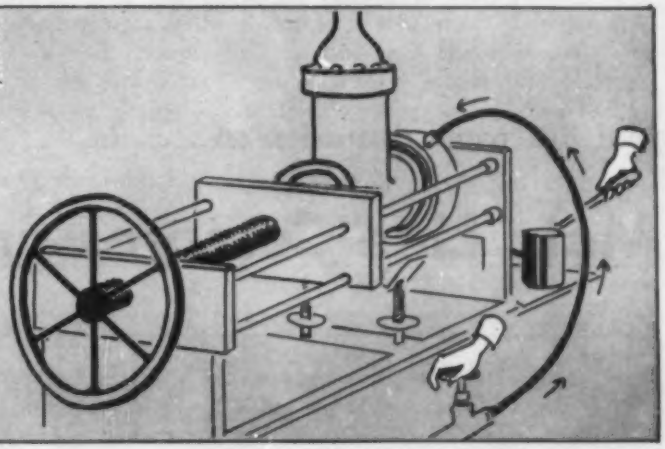
1. First the "O" rings are applied in one of grooves in head.



2. Valve is placed on leveling blocks, heads moved into position with handwheel.



3. Heads are forced against valve with hydraulic ram.



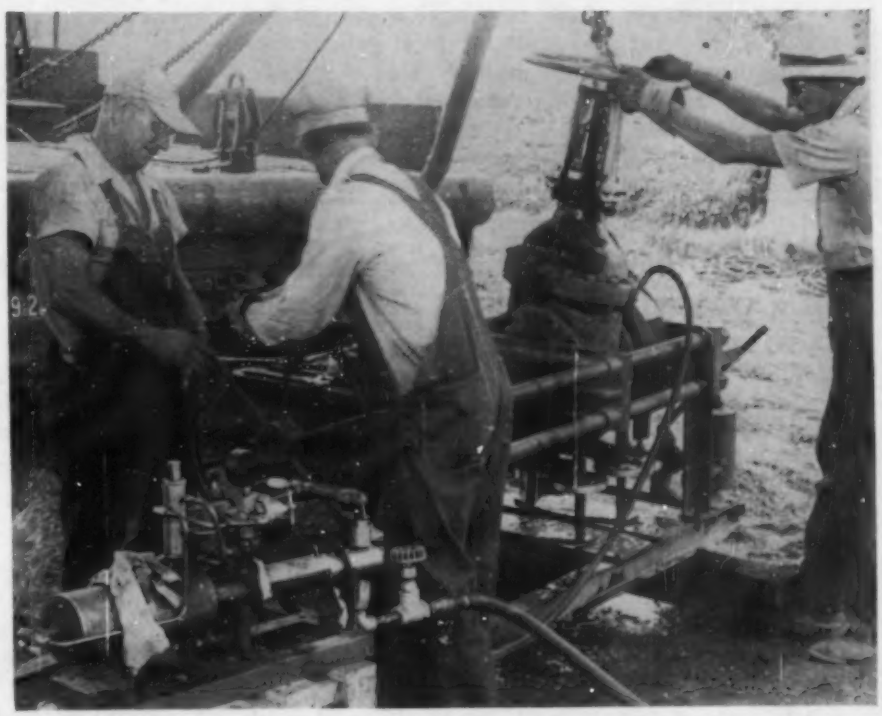
4. Hydraulic pump is started for test.

in the proper grooves or heads. The gate valve is opened and usually the stem packing gland is loosened to bleed off air as the valve is filled with water. Water is pumped into the valve through holes centered in the heads.

After the valve is filled with water the stem packing gland is tightened and pressure run up with an air-operated test pump. With compressed air at 100 pounds per square inch the pump is capable of developing 6000 psi hydraulic pressure. The machine tests the body of the valve and the tightness of the valve seats. Valves are tested to ASA ratings.

The actual valve test, that is, after the valve is placed in the machine and filled with water, takes about ten minutes.

Men in the maintenance department are pleased with the machine's performance and feel it will solve the problems they have had in the past with second-hand gate valves. And that will mean a savings of time and money. **—The End**



TESTER IN ACTION. Pump at left supplies the water. This test was run before grooved head (No. 2 on preceding page) was added to machine. The way the machine is operating here, valve will have to be turned end for end to test other valve seat.

PANEL MEMBERS are, left to right, F. B. Haverfield, W. E. Worley, W. H. Miller and Hugh F. Steen.

Join this panel discussion on . . .

Main Line Compressor Stations

One of the best ways to keep up with the latest trends and advances in the gas industry is to attend the Annual Short Course in Gas Technology sponsored by the Southern Gas Association at Texas College of Arts and Industries at Kingsville, Texas. Under the direction of Texas A and I's Dr. Frank Dotterweich, the yearly meeting has evolved into one of the most important technical get-togethers held throughout the gas industry. One of the outstanding features of this year's meeting was the panel discussion on compressor station operations. Heading the panel as moderator was Hugh F. Steen, vice president and general superintendent, El Paso Natural Gas Company. The other three members were: F. B. Haverfield, superintendent of compressor stations, Transcontinental Gas Pipe Line Corporation; W. E. Worley, superintendent of compressor stations, Texas Eastern Transmission Corporation and W. H. Miller, operator-manager of El Paso Natural Gas Company's Southern division. With the help of Texas A & I staff members, PIPE LINE INDUSTRY was able to record the session for its readers. Here are the highlights of this discussion.

Q. Compare the operation of a steam-powered centrifugal compressor station with that of a conventional reciprocating station.

A. (Haverfield) First, let me describe Transco's three 15,000-horsepower, steam-powered stations. Each one has 3 43,000-pound boilers and 3 5000-horsepower steam turbines which drive the centrifugal compressors. These compressors are piped in series with each one raising the gas pressure about 100 pounds per square inch.

Since they have only been in operation about 3½ years it is not easy to evaluate their performance. The comparison with reciprocating stations is favorable. The fuel costs run higher than that of reciprocating stations but the labor and maintenance costs run less. On the whole they compare favorably with the conventional stations. There isn't a dollar's difference per installed horsepower per year.

Q. *What is the thermal efficiency?*

A. Approximately 21 percent. Fuel consumption runs about 10 cubic feet per horsepower hour.

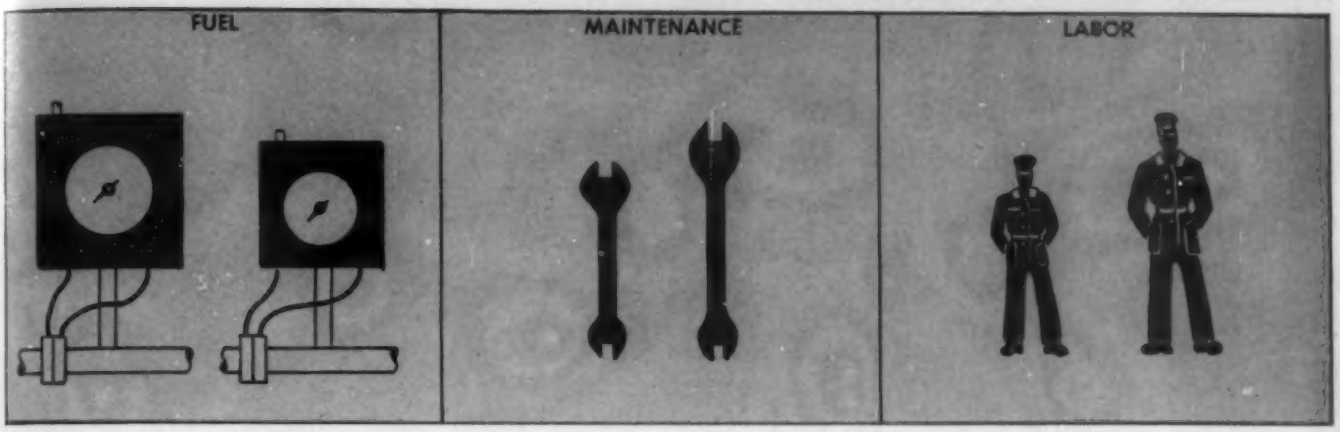
Q. *How many men are required to each station?*

A. Transco uses 19 men, and this includes supervisory personnel.

Q. *How about availability?*

A. In our initial operations we had a number of mechanical difficulties which had to be overcome. Once they were ironed out availability has consistently run high. Last year we had one station which had an availability of 99.4 percent. This is higher than reciprocating stations.

Q. *What is the over-all compression ratio?*



A. It runs about 1.6. Incidentally, we are consistently operating one station on overload. It is developing 16,800-horsepower or 112 percent of design load.

Q. *What are the chief disadvantages to steam-powered compressor stations?*

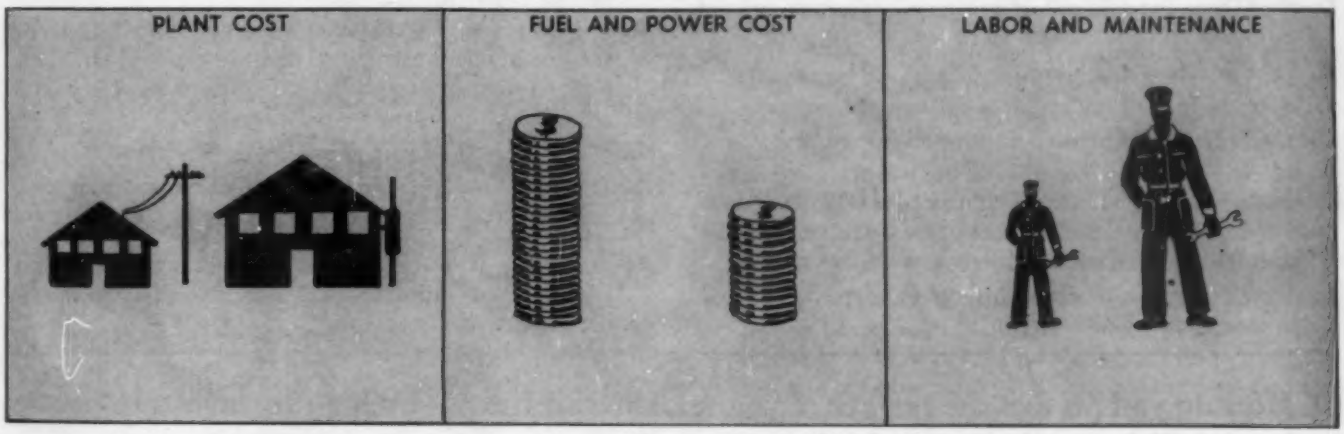
A. The biggest disadvantage is that the compressor equipment is in big chunks. When one of the 5000-horsepower units goes out of service it seriously impairs operations.

Q. *What are the main factors governing the selection of this type power for gas compression?*

A. From start to finish it is a matter of economics. Water supply for the boilers is the first and most important factor to be looked into before selecting this design. Comparison ratios would have to be within the range of centrifugal design.

Q. *How much make-up water do the stations use?*

A. About 6000 barrels of water per day.



Q. Compare the operation of an electric-powered station with that of a reciprocating station.

A. (Worley) Texas Eastern operates 19 electric-powered centrifugal stations on its system. Gas is compressed in four stages at all but two of these stations. The over-all station compression ratio is 1.5. Two of the stations provide six-stage compression which gives a compression ratio of 1.75.

Q. *How do costs compare?*

A. The capital outlay for an electric powered station is much less than that of a conventional station. However, the cost of electric power is considerably higher than the cost of fuel gas.

Q. *How about availability and maintenance?*

A. During 1953 Texas Eastern had 121 outages on its entire system due to power supply failure. But these outages represented the equivalent of only 170 hours total downtime for one unit. When this is compared with operating time which was approximately 1,100,000 unit hours it is almost infinitesimal.

Q. *How many men are required to operate a station?*

A. Twelve including maintenance and repair forces.

Q. *What are the chief sources of trouble?*

A. In the early days of operation the centrifugal compressor was being used for the first time in compressor stations. However, the bugs in this piece of equipment have long since been worked out. Today, the chief source of trouble is voltage dips and current outages. However, they are not serious.

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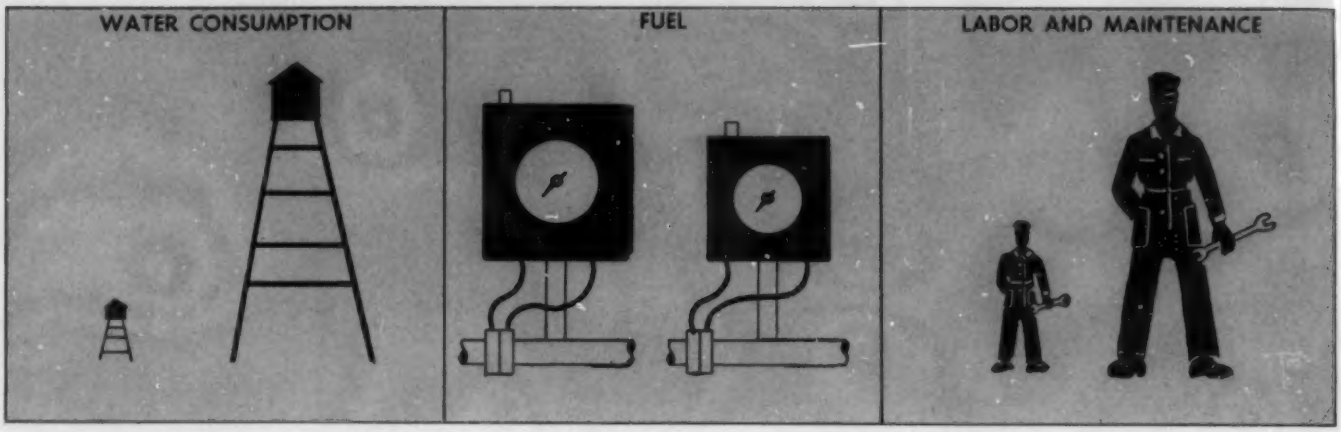


Q. Compare the operation of the gas-fired centrifugal compressor with conventional reciprocating stations.

A. (Miller) About three years ago El Paso Natural needed a great deal of additional horsepower. The number one problem that guided the selection of units was the extreme scarcity of water in the arid country of West Texas, New Mexico and Arizona. In this respect, the gas turbine was a natural since its water consumption is negligible. To date we have installed 28 of these turbines which have a total of about 150,000 horsepower.

Q. *How does the initial cost compare with conventional stations?*

A. It runs about the same.

Q. *How many men are required to man the station?*

A. (Miller) At the present time we use seven men.

A. (Steen) This does not include the two traveling maintenance crews which are stationed at El Paso and Tucson, Ariz. At present these crews perform routine maintenance and modifications as well.

Q. *Are the stations designed for supervisory control and remote operations?*

A. Yes, as a matter of fact, they are entirely operated by pushbuttons.

Q. *Have you reduced the noise level since you started operating the stations?*

A. Yes. We greatly reduced the noise level by insulating piping and in one case, removing straightening vanes from compressors.

Q. *Do the turbines afford much flexibility in operation so far as dispatching is concerned?*

A. (Miller) Yes. The turbines have two shafts: One for the axial compressor; one for the load shaft. This permits the speed of the compressor to be varied with load.

Q. *What is the fuel gas consumption?*

A. It runs about 10 cubic feet per horsepower hour.

Q. *What is the horsepower rating of the units?*

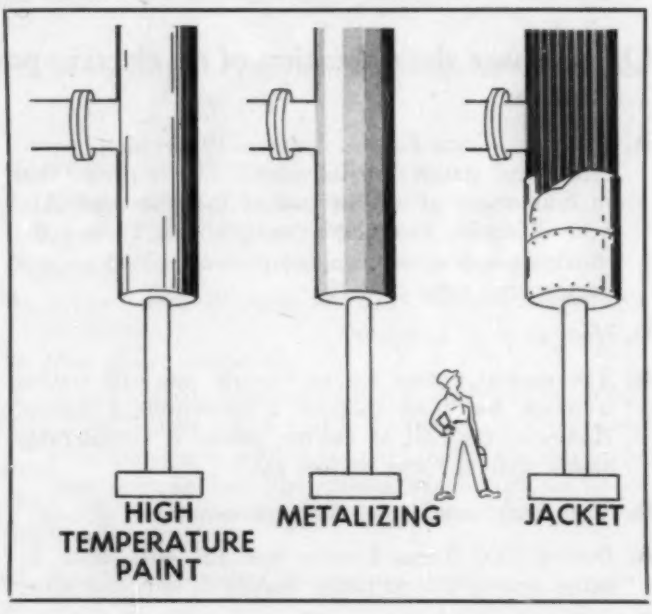
A. Originally it was 5000, but the manufacturer has increased this rating to 5750 with absolutely no modifications to the machines.

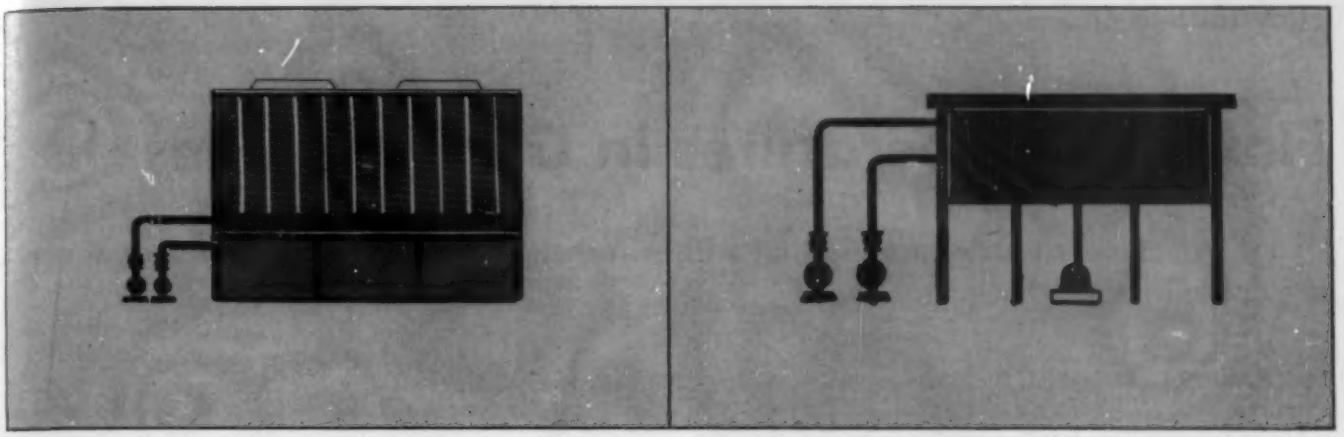
Q. How do you protect the surface of your exhaust silencers—by high temperature paint; by metalizing or by insulation?

A. (Haverfield) Where corrosion is difficult to control we use metalizing. Where noise level is important we use insulation with high ribbed metal lathe next to the silencer. The latter is more expensive, but once it has been installed, there is little or no maintenance.

A. (Worley) Texas Eastern usually installs an 18 to 20 gauge aluminum jacket around the outside of the silencer shell, with an air space separating the shell and the jacket. The entire assembly is painted with high temperature paint. The advantage of the installation is the negligible maintenance.

A. (Miller) El Paso Natural has used all three types of protection. In our opinion the jacket is the best one.

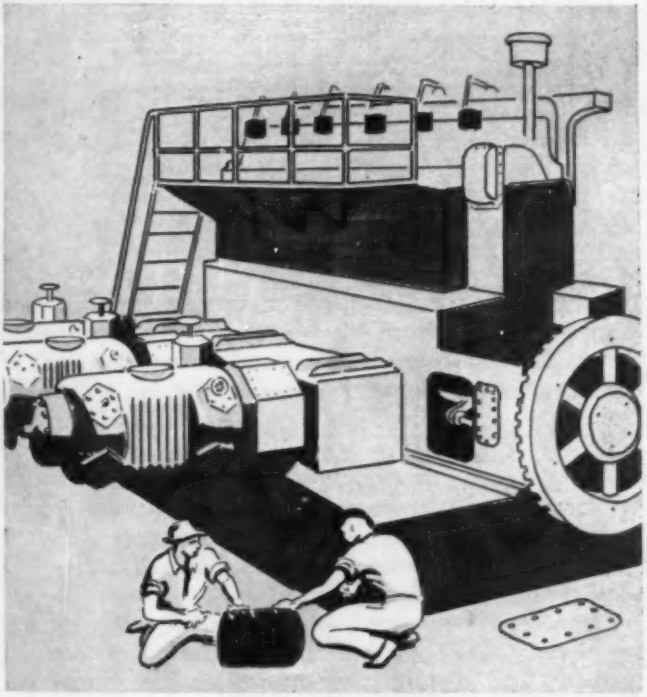




Q. What are the advantages and disadvantages to cooling discharge gas?

A. (Steen) The single advantage to cooling discharge gas is that it minimizes the plastic flow of the pipe coating, which protects the pipe from corrosion.

A. (Worley) Texas Eastern does not use cooling on discharge gas. Compression ratios of the stations are fairly low so that temepratures of discharge gas—even in summer—do not exceed 140° F. We have used the money that would have been spent for cooling equipment to install additional horsepower to push gas down the line. We feel we have effected a considerable savings.



Q. *What is the difference in cost in cooling gas by cooling tower and atmospheric cooling sections?*

A. (Miller) We have found that the cost of cooling discharge gas with atmospheric cooling sections to be about 1⅓ times that of conventional cooling tower costs, where water supply is ample.

A. (Haverfield) Transco uses cooling towers at nine stations and atmospheric dry coolers at six. We agree with Mr. Miller on comparative costs.

Q. *What are the problems most likely to be encountered in the installation of hydraulic drive systems for atmospheric coolers and auxiliary equipment?*

A. (Steen) We use hydraulic drives to furnish motive power for auxiliary units at several field compressor stations. It has proved very satisfactory. Originally, we had trouble with air locks in the system. This was overcome by installing surge tanks in top of the buildings.

A. (Miller) The engineering and design of this equipment has improved immensely in the last year or so. We will see more of these installations used in the future. Another difficulty which is sometimes encountered with this type of equipment is mill scale and rust inside the piping. Pipe should be thoroughly cleaned before the system is placed into operation.

Q. Describe the preventive maintenance program which you employ on compressor stations.

A. (Haverfield) We make 30-day checks on all of our engines. These checks are short, averaging only 35 minutes or so. We change sparkplugs, interruptors and check vulnerable parts of the engine. We have regular maintenance overhauls every 8000 to 10,000 hours.

A. Mr. Worley and Mr. Miller followed this same general plan.

Q. *Do you use magniflux in inspection prior to overhaul?*

A. Transco does; Texas Eastern and El Paso Natural do not except on special occasions. All three companies plan to make greater use of magniflux in the future.

Q. *What parts have you been magnifluxing?*

A. (Haverfield) Connecting rod bolts and connecting

Continued on Page 97

How to determine . . .

Flowing Temperatures in Gas Pipe Lines

Here's a new formula that will help designers determine the amount of cooling needed for discharge gas.

By CHARLES E. SCHORRE, Transcontinental Gas Pipe Line Corporation, Houston

GAS TEMPERATURE distribution along a buried gas transmission line under steady flow conditions is dependent upon three effects:

- Heat may either be conducted from the gas into the ground or vice versa, causing either a gas temperature increase or decrease;
- There will be a temperature decrease due to the Joule Thompson effect, which is the change in temperature with pressure, with no change in enthalpy;
- There will be a decrease in gas temperature due to the velocity increasing in the lower pressure sections of the pipe line.

In solving most gas transmission problems it is necessary to consider only the heat transfer and Joule Thompson effects. As a matter of fact the Transcontinental pipe line temperature drop due to velocity increasing is only .5° F. or so.

If the flow is not steady and gas is either withdrawn from line pack or placed in line pack the methods of calculation set forth in this paper do not strictly apply.

How the tests were made. There is little mention of the Joule Thompson effect on flowing temperatures in literature. Practically nothing has ever been said about gas temperatures getting down below the temperature of the surrounding soil. Yet, almost every section of main line pipe that has been checked on the Transcontinental system has shown gas temperatures to be below that of the surrounding ground temperature. Figures 1, 2 and 4 reflect this condition for various sections of Transco's main line.

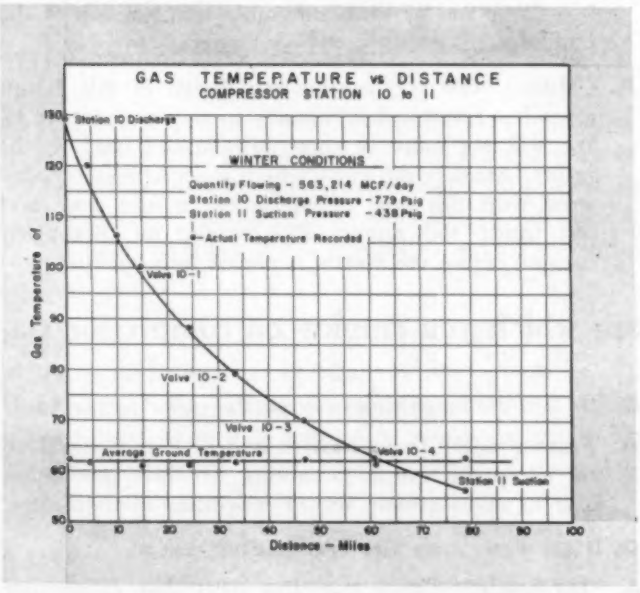


FIGURE 1

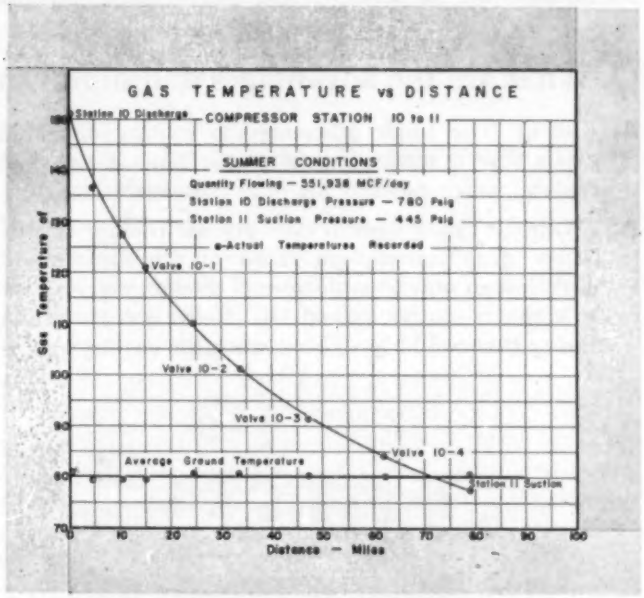


FIGURE 2

All of the gas temperature readings were taken with thermocouples. A probe rod with a thermocouple on the point was used to take ground temperatures. In most cases, these temperatures were taken at distances of about 15 feet from the pipe line.

Figure 1 was prepared as an aid to determining the amount of Joule Thompson effect. If the initial and final pressures and temperatures of a pipe line section are known, the effect can be readily determined using this Enthalpy-Pressure-Temperature chart.

In order to calculate the temperature distribution along the pipe line it was necessary to derive a single equation to include the different temperature effects mentioned above. This equation is:

$$\text{Log}_{10}\left[\frac{(T_1 + Jx_1) - (T_g + \frac{J}{a})}{(T_2 + Jx_2) - (T_g + \frac{J}{a})}\right] = \frac{aX}{2.303}$$

Where: $a = \dfrac{2\pi RU}{q\,Cp}$

$\pi = 3.1416$

R = pipe radius, ft.
U = heat transfer coefficient, BTU/(hr.) (deg. F.) (Sq. Ft.)
q = gas flowing, Mcf/hr.
Cp = specific heat of gas, 24 BTU/(deg. F.) (MCF)
J = Joule Thompson effect, deg. F./ft. of pipe
X_1 = distance in feet to T_1 from initial point
X_2 = distance in feet to T_2 from initial point
$X = X_2 - X_1$, ft.
$\frac{J}{a}$ = temperature difference between the ground and gas which would be necessary to hold the gas temperature constant.
T_1 = initial gas temperature at point X, deg. F.
T_2 = gas temperature at point X_2, deg. F.

It is believed that this equation has never appeared in any literature published to date.

To use this equation field data must be obtained so that a value of "U" may be determined. Using the data shown in Figure 1, the "U" value is determined as follows.

Sample calculations for determining "U". Compressor Station 10 to 11 using Figure 1. Assume a "U" value and calculate the suction temperature at Station 11. If the calculated temperature equals the actual recorded temperature, the "U" value is correct. If the calculated temperature is not equal to the actual temperature, a new "U" value must be assumed and the entire procedure duplicated. From Figure 3:

$J = \frac{14^\circ \text{ F.}}{78.89 \times 5280} = 3.37 \times 10^{-5}$ °F./ft. Drop due to Joule Thompson

Assume "U" = .55 BTU/Hr./Ft.²/°F.

$$\text{Then } a = \frac{2 \times 3.14 \times 1.25 \times .55}{\frac{563{,}214 \times 24}{24}} = 7.67 \times 10^{-6}$$

$\frac{J}{a} = \frac{3.37 \times 10 - 5}{7.67 \times 10 - 6} = 4.39^\circ$ F. equilibrium temperature between the ground and gas

X = 78.89 miles

$Jx = 3\ 37 \times 10^{-5} \times 78.89 \times 5280 = 14^\circ$ F. Total drop due to Joule Thompson

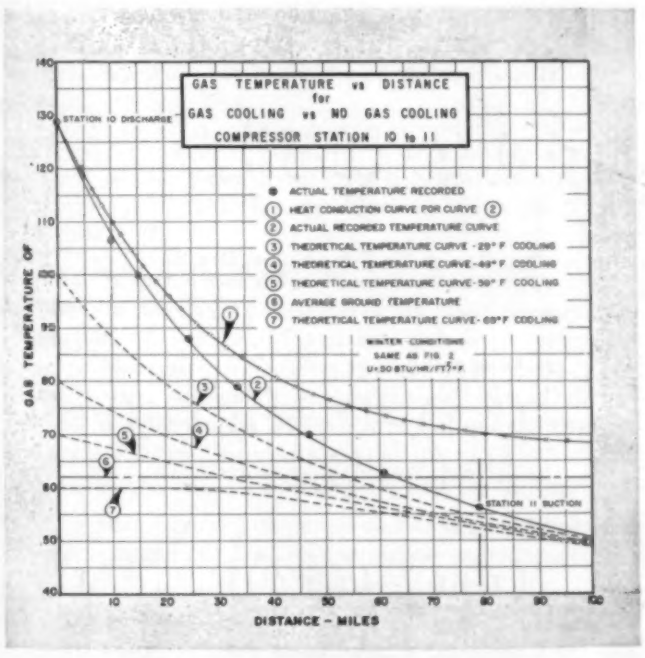

GAS TEMPERATURE vs DISTANCE
for
GAS COOLING vs NO GAS COOLING
COMPRESSOR STATION 10 to 11
STATION 10 DISCHARGE
STATION 11 SUCTION
ACTUAL TEMPERATURE RECORDED
HEAT CONDUCTION CURVE FOR CURVE ②
ACTUAL RECORDED TEMPERATURE CURVE
THEORETICAL TEMPERATURE CURVE - 20° F COOLING
THEORETICAL TEMPERATURE CURVE - 40° F COOLING
THEORETICAL TEMPERATURE CURVE - 50° F COOLING
AVERAGE GROUND TEMPERATURE
THEORETICAL TEMPERATURE CURVE - 60° F COOLING
WINTER CONDITIONS
SAME AS FIG. 2
U = 50 BTU/HR/FT²/°F
GAS TEMPERATURE OF
DISTANCE - MILES

FIGURE 4

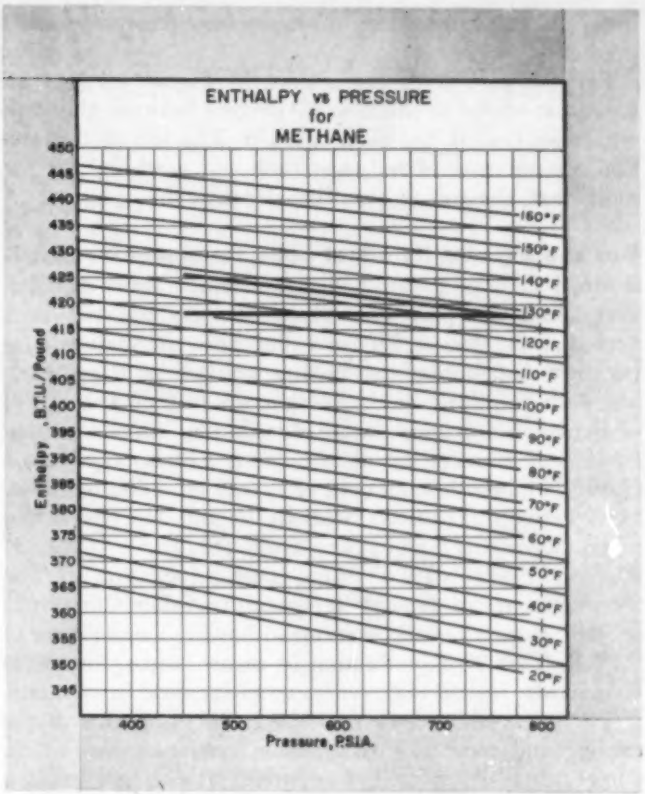


FIGURE 3

$$\text{Log}_{10}\left[\frac{(129+0)-(62+4.39)}{(T_2+14)-(62+4.39)}\right] = \frac{7.67 \times 10^{-6} \times 78.89 \times 5280}{2.303}$$

$T_2 = 54.9^\circ$ F.
The value assumed for "U" is incorrect since the actual recorded temperature is 56° F.

Assume another value of "U" and recalculate.

"U" = .50

$$a = \frac{6.28 \times 1.25 \times .5}{\frac{563{,}214 \times 24}{24}} = 6.98 \times 10^{-6}$$

$$\frac{J}{a} = \frac{3.37 \times 10^{-5}}{6.98 \times 10^{-6}} = 4.83^\circ \text{ F.}$$

$$\text{Log}_{10}\left[\frac{(129+0)-(62+4.83)}{(T+14)-(62+4.83)}\right] = \frac{6.98 \times 10^{-6} \times 78.89 \times 5280}{2.303}$$

$T_2 = 56.2^\circ$ F.
which compares favorably with actual recorded suction temperature.

"U" = .50 BTU/Hr./Ft.²/° F.

Sample calculations to further check the "U" value. Assume X = 40 miles and compare calculated temperature with actual recorded temperature.

$Jx = 3.37 \times 10^{-5} \times 40 \times 5280 = 7.12^\circ$ F.

$$\text{Log}_{10}\left[\frac{(129+0)-(62+4.83)}{(T_2+7.12)-(62+4.83)}\right] = \frac{6.93 \times 10^{-6} \times 40 \times 5280}{2.303}$$

$$\text{Log}_{10}\left[\frac{62.2}{(T_2+7.12)-66.83}\right] = .640$$

$$\left[\frac{62.2}{(T_2+7.12)-66.83}\right] = 4.36$$

$T_2 = 73.9^\circ$ F. which compares favorably with actual recorded temperature of 74° F.

After "U" has been established it can be used to determine a gas temperature at any point on the pipe line section for any flowing quantity and any temperature condition. However, "U" is subject to variation due to soil conditions, which probably will vary over a period of

time, and may introduce an error into the temperature prediction.

For the section of line shown in Figure 1, the "U" value has varied as much as 20 percent between the various times that it has been checked. The soil in this section is a mixture of red clay, rock and sand and for the most part, the soil at pipe line depth is dry.

Gas cooling and its effect upon temperature distribution. Figures 1 and 2 illustrate temperature distribution along the pipe line where the gas has not been cooled at the station. Figure 4 illustrates the various temperature distribution curves that would exist if gas cooling were employed at the compressor station. Curve (1) of Figure 4 is a temperature distribution curve resulting from heat transfer by conduction and is based upon Curve (2), which is a curve of actual recorded temperatures between Transco's Stations 10 and 11. The actual mean flowing temperature from this curve is 80° F. Curve (3) reflects 29° F. of gas cooling at Station 10. The theoretical mean flowing temperature using Curve (3) is 70.9° F. or a reduction in mean flowing temperature of 9.1° F. This 9° F. reduction in mean flowing temperature results in less than one percent increase in capacity.

There has been much said about the economics of gas cooling and some gas transmission systems have cooling while others do not. Transcontinental has gas cooling facilities in all but three compressor stations and cools the gas approximately 35° F. This cooling lowers the mean flowing temperature approximately 11° F. The final decision to either install or delete gas cooling on a gas transmission system is dependent upon economics. However, it is an important consideration in the design of gas transmission systems and should be studied completely.

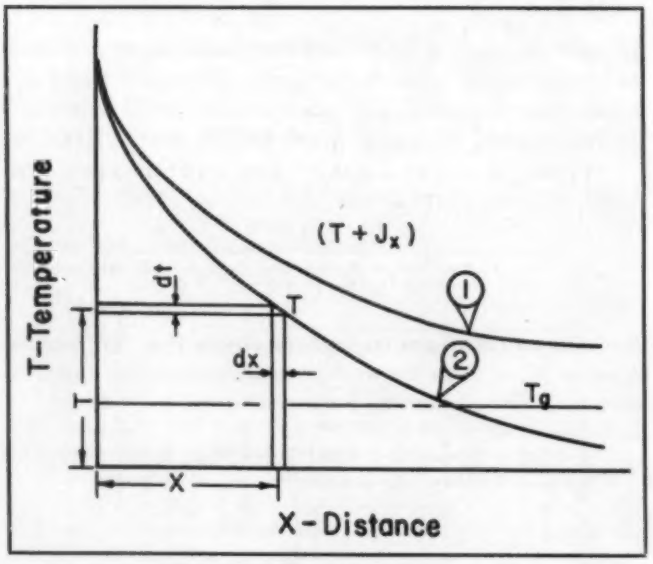


FIGURE 5

① = Heat Conduction Curve for Curve ②
② = Actual Gas Temperature Curve
J = Joule-Thompson effect in deg. F. per ft of pipe and is the Value between Curve ① and ②
Jx = deg. F. Drop due to Joule-Thompson effect at distance x

$\frac{Q}{\Theta} = UA\Delta T$

Q = heat transferred, BTU
Θ = time, hrs.
ΔT = temperature difference between gas and ground, deg. F.
U = overall heat-transfer coefficient, BTU/(sq. ft.)/(deg. F.)/(hr.)
A = area, sq. ft.

$\therefore \frac{Q}{\Theta}$ = heat transferred from gas to ground, BTU/hr.

$\Delta T = [(T + J_x) - T_g]$ driving force temperature for conduction only

where:

T = actual gas temperature at any point, deg. F.
T_g = ground temperature, deg. F.
$A = 2\pi rx$
$\pi = 3.1416$
r = outside radius of pipe, ft.
x = length of pipe, ft.

then:

$^*Q = 2\pi rU\,[(T + J_x) - T_g]\,dx$

$^*Q = -qC_p dt$

where: q = MCF/hr. gas flow
C_p = specific heat of gas, 24 BTU/(deg. F.)/(MCF)
dt = change in gas temperature, deg. F.

$\therefore -qC_p dt = 2\pi rU\,[(T + J_x) - T_g]\,dx$

$dt = \frac{2\pi rU}{-qC_p}[(T + J_x) - T_g]\,dx$ Change in gas temperature due to conduction only

Let $-a = \frac{2\pi rU}{-qC_p}$ which is a constant

Actual Change in gas temperature = Heat Conduction change + Joule-Thompson Effect

$dt = -a\,[(T + J_x) - T_g]\,dx + J dx$

$dt = \left\{-a\,[(T + J_x) - T_g] + J\right\} dx$

$\frac{dt}{a} = \left\{-[(T + J_x) - T_g] + \frac{J}{a}\right\} dx$

$\frac{dt}{a} = \left\{[(T + J_x) - T_g] - \frac{J}{a}\right\} dx$

$\frac{dt}{a} = -\left[\left(T + J_x\right) - \left(T_g + \frac{J}{a}\right)\right] dx$

$$\frac{dt}{\left[\left(T + J_x\right) - \left(T_g + \frac{J}{a}\right)\right]} = -a\,dx$$

$\frac{J}{a}$ = a constant and is the temperature difference between the ground and the gas which would be necessary to hold the gas temperature constant.

Let $C = J_x$ which is a function of dt at point T.

* Carries negative sign due to heat loss.

$$\int_{T_1}^{T_2} \frac{dT}{\left[\left(T + C\right) - \left(T_g + \frac{J}{a}\right)\right]} = -a \int_0^x dx$$

where:

T_1 = Initial Gas Temperature, Deg. F.
T_2 = Gas Temperature at Distance x, Deg. F.

using integral form

$$\int \frac{du}{u} = \text{Log}_e\, u$$

$$\text{Log}_e\left[\left(T + C\right)_2 - \left(T_g + \frac{J}{a}\right)\right] - \text{Log}_e\left[\left(T + C\right)_1 - \left(T_g + \frac{J}{a}\right)\right] = -a(x - o)$$

and changing signs

$$\text{Log}_{10}\frac{\left[\left(T_1 + J_{x1}\right) - \left(T_g + \frac{J}{a}\right)\right]}{\left[\left(T_2 + J_{x2}\right) - \left(T_g + \frac{J}{a}\right)\right]} = \frac{ax}{2.303}$$

This is the equation for finding the gas temperature at any point.

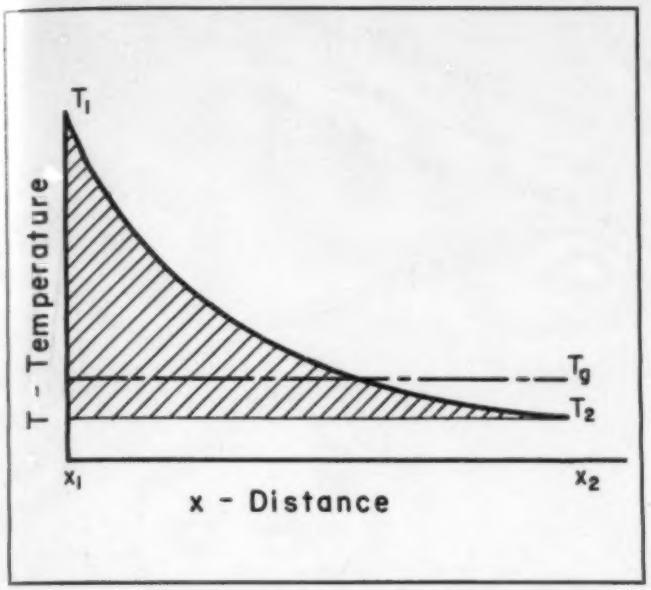


FIGURE 6

Equation for finding T_2 at distance x_2.

$$\text{Log}_{10}\left[\frac{\left(T_1+Jx_1\right)-\left(T_g+\frac{J}{a}\right)}{\left(T_2+Jx_2\right)-\left(T_g+\frac{J}{a}\right)}\right]=\frac{a\,x}{2.303}$$

$$\text{Mean Flowing Temperature}=\frac{\text{Area Under Curve}}{\text{Length (x)}}$$

$$\text{Area Under Curve}=\int_0^x \text{equation of Temp. curve}\cdot dx$$

Equation for Temperature Curve
Solving for T_2 at Point x_2;

$$T_2=\left[\frac{\left(T_1+Jx_1\right)-\left(T_g+\frac{J}{a}\right)}{e^{ax}}\right]+\left[\left(T_g+\frac{J}{a}\right)-Jx_2\right]$$

$$\text{Mean Flowing Temperature}=\frac{\int_0^x\left\{\left[\left(T_1+Jx_1\right)\left(-T_g+\frac{J}{a}\right)\right]e^{-ax}+\left[\left(T_g+\frac{J}{a}\right)-Jx_2\right]\right\}dx}{X}$$

when:
$x=x_2-x_1;\ x_1=0;\ x=x_2;\ T_1=\text{constant}$
$\left(T_g+\frac{J}{a}\right)=\text{constant}$

$$MFT=\frac{\int_0^x\left[T_1-\left(T_g+\frac{J}{a}\right)\right]e^{-ax}\,dx+\int_0^x\left[\left(T_g+\frac{J}{a}\right)-Jx\right]dx}{X}$$

$$MFT=\frac{T_1-\left(T_g+\frac{J}{a}\right)\int_0^x e^{-ax}\,dx+\left(T_g+\frac{J}{a}\right)\int_0^x dx-J\int_0^x x\,dx}{X}$$

$$MFT=\frac{\left[T_1-\left(T_g+\frac{J}{a}\right)\right]\left[\frac{1-e^{-ax}}{a}\right]+\left(T_g+\frac{J}{a}\right)X-\frac{Jx^2}{2}}{X}$$

$$MFT=\left[T_1-\left(T_g+\frac{J}{a}\right)\right]\left[\frac{1-e^{-ax}}{ax}\right]+\left[\left(T_g+\frac{J}{a}\right)-\frac{Jx}{2}\right]$$

This is the equation to use to determine the mean flowing temperature.

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[1] Dunkle, R. U. "Predicting Temperature Distribution Along Gas Transmission Pipe Lines." *Gas*, (September, 1942), p. 31.

ACKNOWLEDGMENTS

This is a condensation of a paper presented at the Short Course in Gas Technology, Texas College of Arts and Industries, Kingsville, Texas, June 2-4 1954.

—The End

Main Line Compressor Stations

Continued from Page 93

rods. We have not magnifluxed the crankshafts.

Q. *Do you X-ray all welds on gas headers in compressor stations?*

A. Most of the panel agreed on this practice and predicted it would become general throughout the industry.

Q. *Do you overhaul engines singly or in groups?*

A. Transco has had an extremely high load factor during the last year or so. This means that when an engine is off the line it is costing the company money. For this reason we have been overhauling units at all stations simultaneously. We perform this maintenance by keeping forces operating around the clock. This year we overhauled 115 units in 15 days in this manner.

Q. *As a part of your preventive maintenance program do you examine the lube oil for minute metals parts?*

A. None of the panel members' companies did. All of them took samples of lube oil every 60 days. One of the samples is taken down stream from the filter, the other upstream. Company forces run certain tests—refiner runs other tests.

A. A member of the audience suggested that spectrographic analysis made on oil would reflect wear of metallic parts. This analysis will distinguish between bearing metal and piston ring metal. The member of the audience pointed out that a number of railroad companies were employing this method of lube oil analysis to predict trouble before it occurred.

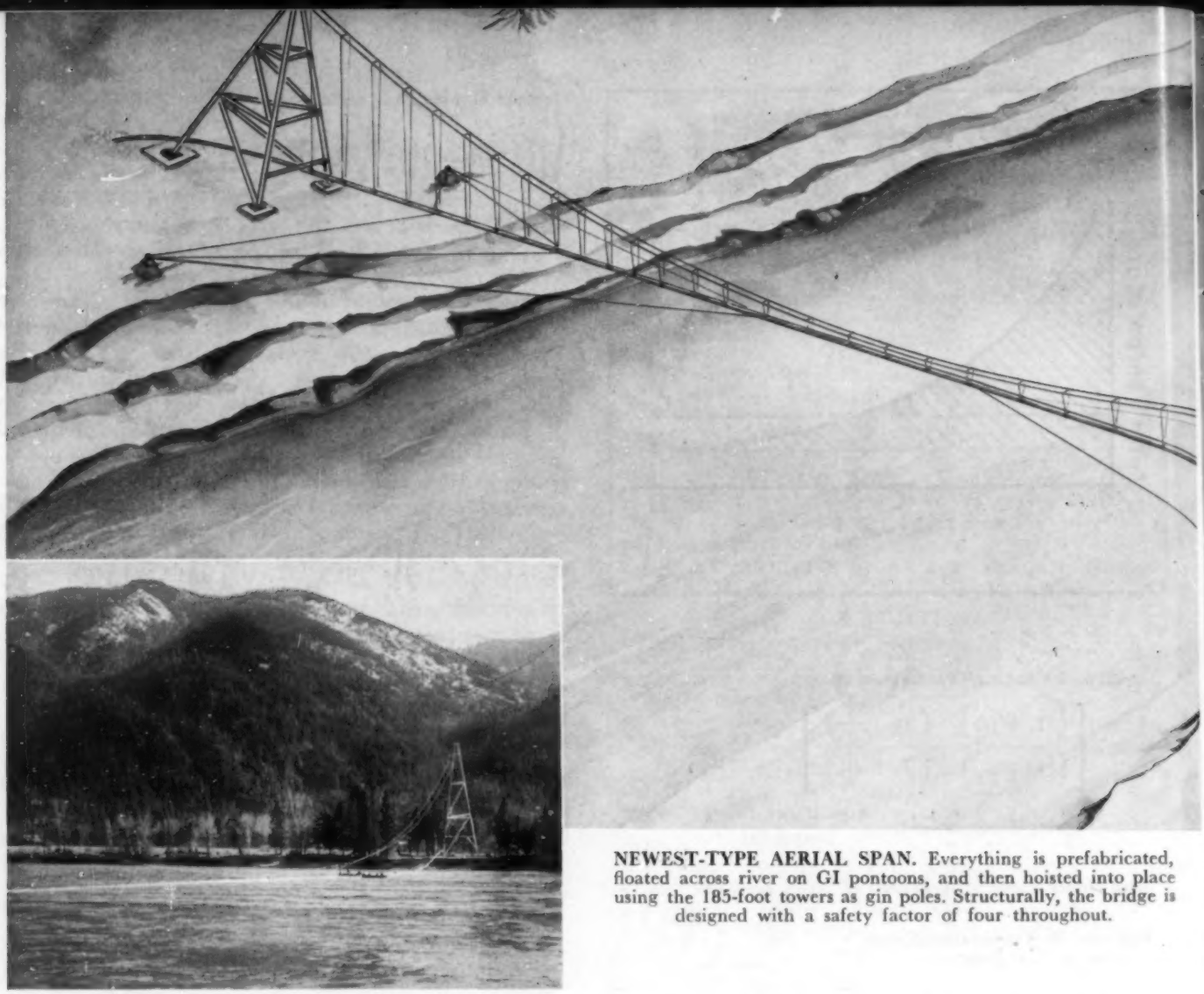
Q. *Do turbine-type stations eliminate the pulsation problems?*

A. The panel agreed that they eliminated most pulsations but increased the likelihood of surging.

The panel also felt that the problem of pulsation on the discharge side of reciprocating compressor stations was far from whipped. They expressed hope that the Southern Gas Association experiment now in progress would provide answers to many of the problems.

A member of the audience pointed out the La Gloria Corporation had used electronic means to design compressor bottles which would minimize pulsation on reciprocating compressors. However, the installation had not been in service long enough to evaluate it.

—The End



NEWEST-TYPE AERIAL SPAN. Everything is prefabricated, floated across river on GI pontoons, and then hoisted into place using the 185-foot towers as gin poles. Structurally, the bridge is designed with a safety factor of four throughout.

1220-Foot Span Raised in One Hour

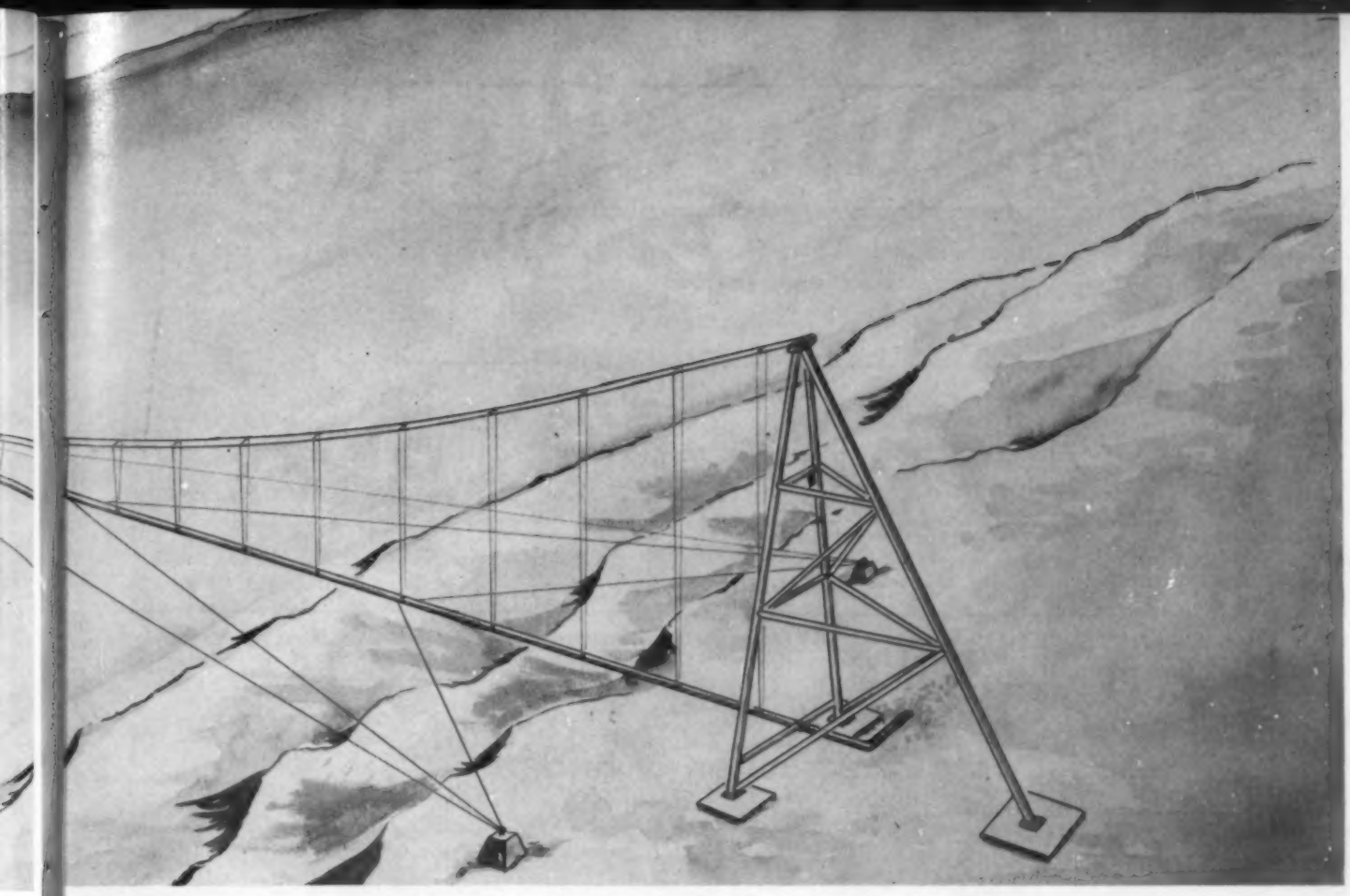
Seven new-type suspension bridges like this have been installed on the Yellowstone System. Bridges are assembled on bank, floated across river, and hoisted aloft by the towers on either side.

By DONALD M. TAYLOR, Editor, PIPE LINE INDUSTRY

THE CLEAR SPAN Engineering Company, Inc., of Houston, Texas, has developed an aerial pipe line suspension bridge for river crossings that can be made up on shore, floated across the water on pontoons and then erected in about an hour's time. The two towers serve as gin poles to hoist the bridge aloft.

Seven of these new bridges were recently installed on the $20,500,000 Yellowstone Pipe Line Company system now under construction. They were used to cross the most difficult streams along the route of the carrier, which runs from Billings, Mont., to Spokane, Wash. The aerial spans vary in length from 450 to 1220 feet.

Because of its simple design and ease of construction, the bridge can be completed in about three weeks' time by an eight-man crew, using very little equipment. As a result of this savings in time and labor, the cost of an aerial suspension bridge is now in the range of an ordinary submarine river crossing.



Design features . . .

One of the outstanding features of the design of the bridge is its simplicity. This makes it easy to analyze and check. It is elementary that in design the triangle is the basis for obtaining rigidity in all structures. (The cross brace breaks up the non-rigid rectangle into two rigid triangles, etc.) For this reason, the triangle was used by designers as the base figure throughout the structure. For instance, the tower is a tripod with a series of triangular members. Even the suspender cables form triangles with the spreaders which separate the main strands.

General design assumptions. A safety factor of four and greater was used throughout the design. The maximum wind loading was assumed to be that developed by a 125-mile-an-hour wind blowing in gusts. Designers also made allowance for ice loading, impact effects, thermal expansion and special test loading. Particular attention was paid to the elimination of certain free movements which have caused "galloping" and harmonic vibration in suspension bridges.

Towers. As can be determined from the drawings, the two front legs of the tripod type tower are in compression, and the back leg is in tension. Engineers agree that in order for the tower to fail under load, the two front legs would have to buckle or the back leg would have to part in tension. It follows that the most critical point in design of the tower is the stiffness (or low slenderness ratio) of the two front legs. This explains why the designers of the bridge went to all welded construction in the tower.

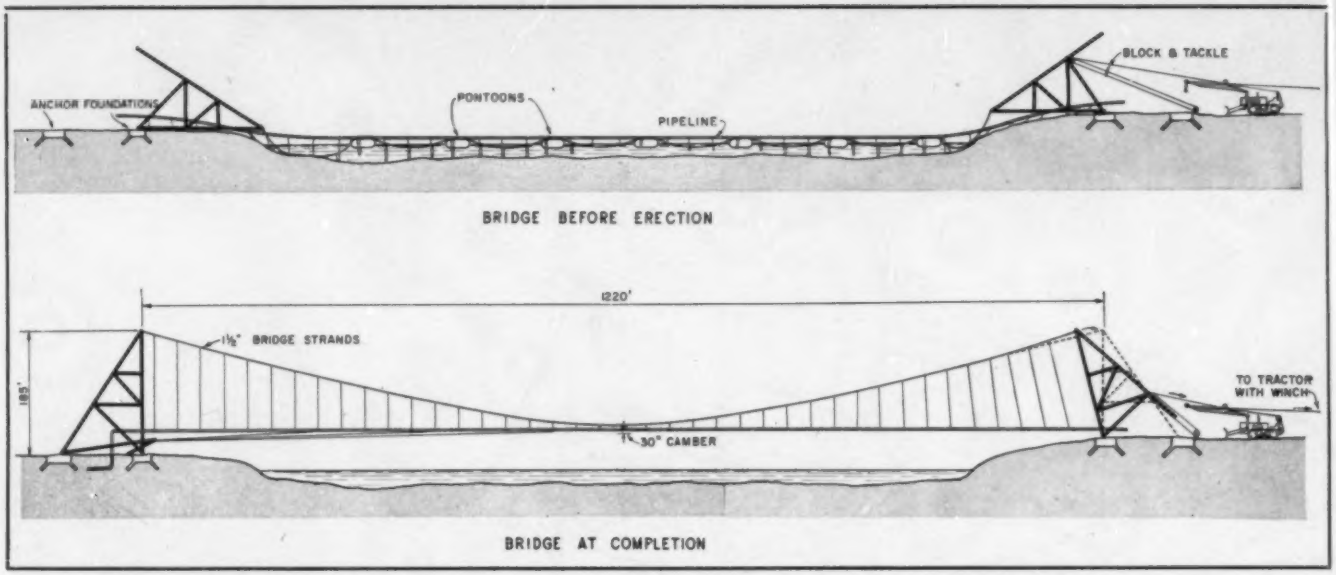
Using a safety factor of four, they first designed the tower as a determinate structure (just as though the structural members were hinged at all joints). But it is obvious that welded joints are more rigid than hinged ones; and an analysis of the tower as an indeterminate structure gives it an added strength of 30 to 35 percent. So the tower exceeds the safety factor.

Main strands. On the Yellowstone line, these strands range from 1⅛ to 1¾ inches in diameter. They are galvanized to prevent corrosion, and the tensile strength of larger size wire rope is rated at 188 tons by the manufacturer. The two strands are separated by steel angle spreaders which vary in length from 5 to 7 feet. They are spaced on 20-foot centers.

One of the design features is that the main strands are not bent over a supporting saddle. This avoids the flattening action and eliminates the abrasive wear that has been responsible for many failures of wire rope.

Suspenders. The suspenders are galvanized one-half-inch wire bridge rope. They run from the main strands to special clamps on the pipe. On the Yellowstone crossings they are spaced every 20 feet, and each suspender panel is designed to carry 3000 pounds.

Pipe line. The lines on the bridges described here are 10¾-inch .322 wall pipe filled (in operation) with gasoline or other products. They are held



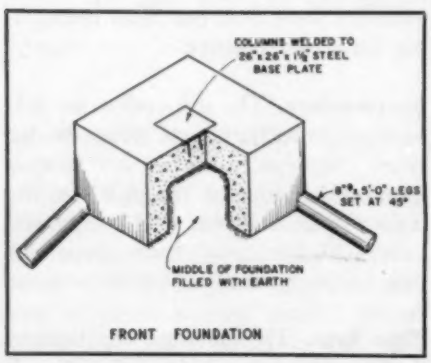
HOW BRIDGE IS HOISTED INTO PLACE. Two towers 185 feet tall are fabricated in horizontal position. They are hinged at the two footings fronting river. With blocks reeved between back footing and tower, the towers can be hoisted aloft easily.

in slight upward camber by the suspenders.

Foundations. This is one of the finer design points on the bridge. Much of the concrete in the footings which would have been dead load has been removed as can be seen by the detail drawing. Yet the bearing capacity of the footing is the same as that of a solid concrete block. This means that the pay load can be higher.

Note also that four legs radiate downward and outward at 45 degrees from each corner of the footing. This gives it greater bearing capacity and greater resistance to overturning moments.

The two front footings beneath the tower are tied together by a heavily reinforced concrete beam. This beam not only holds the two footings together but gives them added bearing capacity.


COLUMNS WELDED TO 26"x26"x1½" STEEL BASE PLATE
8"ø x 5'-0" LEGS SET AT 45°
MIDDLE OF FOUNDATION FILLED WITH EARTH
FRONT FOUNDATION

FOOTING DETAIL. By making the footing hollow, excess weight is removed, giving it a greater payload.

Construction of bridge . . .

Foundations. The first step in construction begins with pouring of the reinforced concrete foundations. This task usually takes four days.

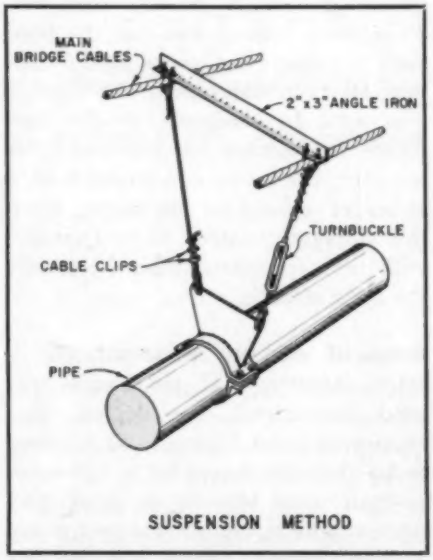
Towers. The second step is to fabricate the towers. As a rule this job takes about ten days and is done concurrently with foundation work. In order that the tower can later be used to hoist the bridge, it is welded together in an overturned position. The two legs fronting the river are hinged to the bearing plates on the front footings to give the tower a pivot as it is pulled upright in the final step in erection of the bridge.

Pipe line. The pipe line is welded up, X-rayed and pressure tested on one side of the river. Later the pipe is tested again after it is on the bridge.

Main strands, suspenders, etc. The main strands are laid parallel to the pipe. Using great care and precise measurements, crews clamp the suspenders to the pipe and to the strands. Next the spreaders are clamped between the two main strands at the point where the suspenders join the main strand.

Preparations for launching. After the previous job has been completed and carefully checked, the entire overhead portion of the bridge (main strands, suspenders and spreaders, etc.) are lashed to the pipe with hemp twine and then clamped onto timber skids or rail rollers for launching.

Launching. This is one of the most ingenious phases of the entire operation. The pipe, with its burden of wire rope, is pulled into the water by a tractor and winch combination or special pulling units. As it enters the water, ordinary rubber rafts are spaced every 80 feet or so beneath it. As the pipe is launched onto the rafts one at a time, they move out into the



PIPE CLAMP DETAIL. Turnbuckles are alternate and have proved unnecessary on bridges constructed so far.

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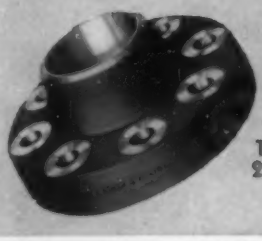

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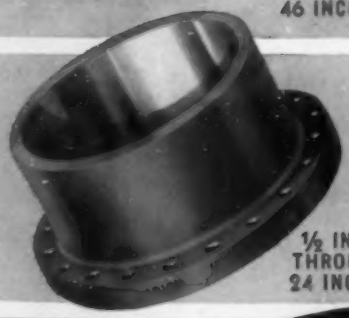
⅛ INCH THROUGH 4 INCHES

6 INCHES THROUGH 46 INCHES



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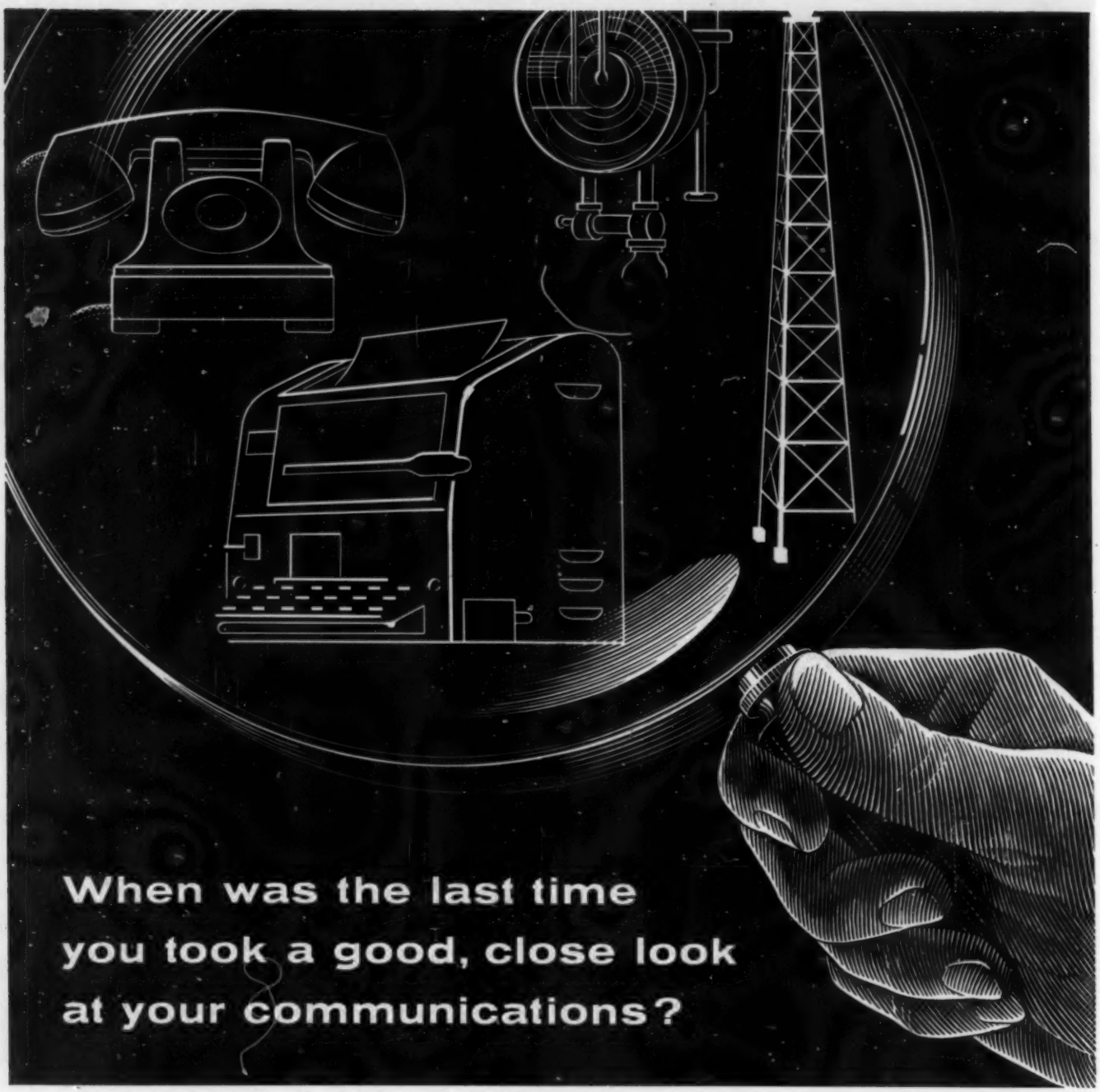

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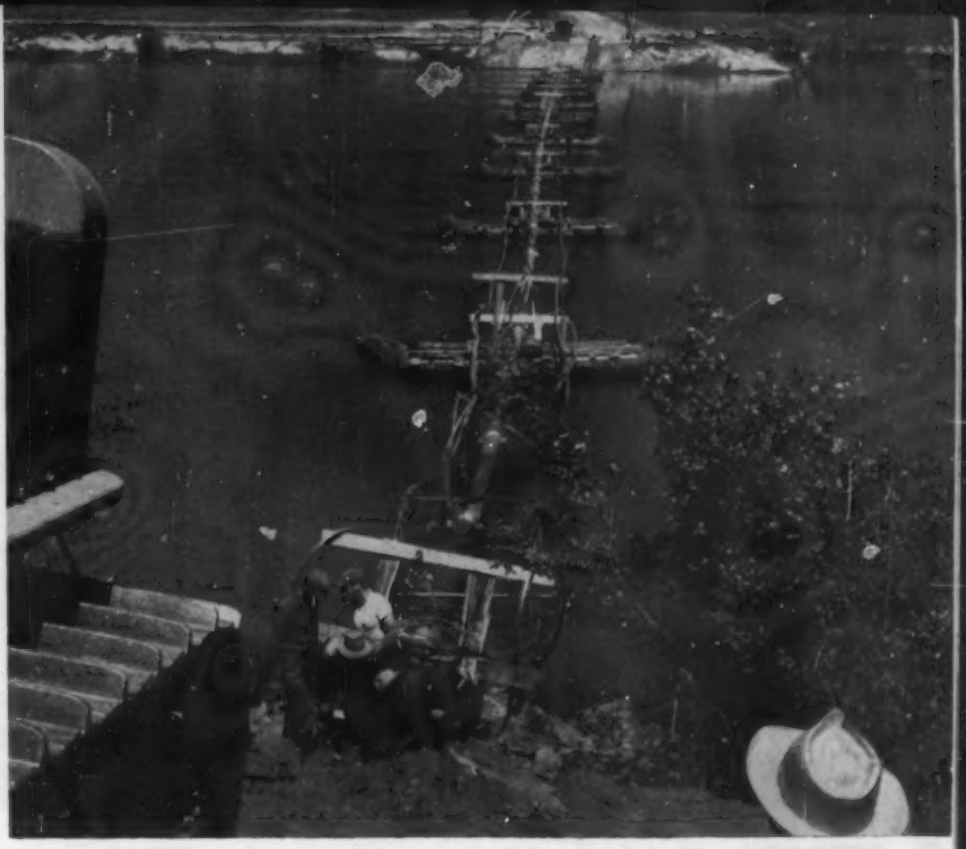
stream along a guide cable which extends all the way across the stream. This cable has previously been laced through nose rings on all of the rafts. This arrangement enables constructors to control the pipe in the water despite currents etc.

After the pipe has been launched across the stream the end sockets of the main strands are clamped to the header clevises atop the tower.

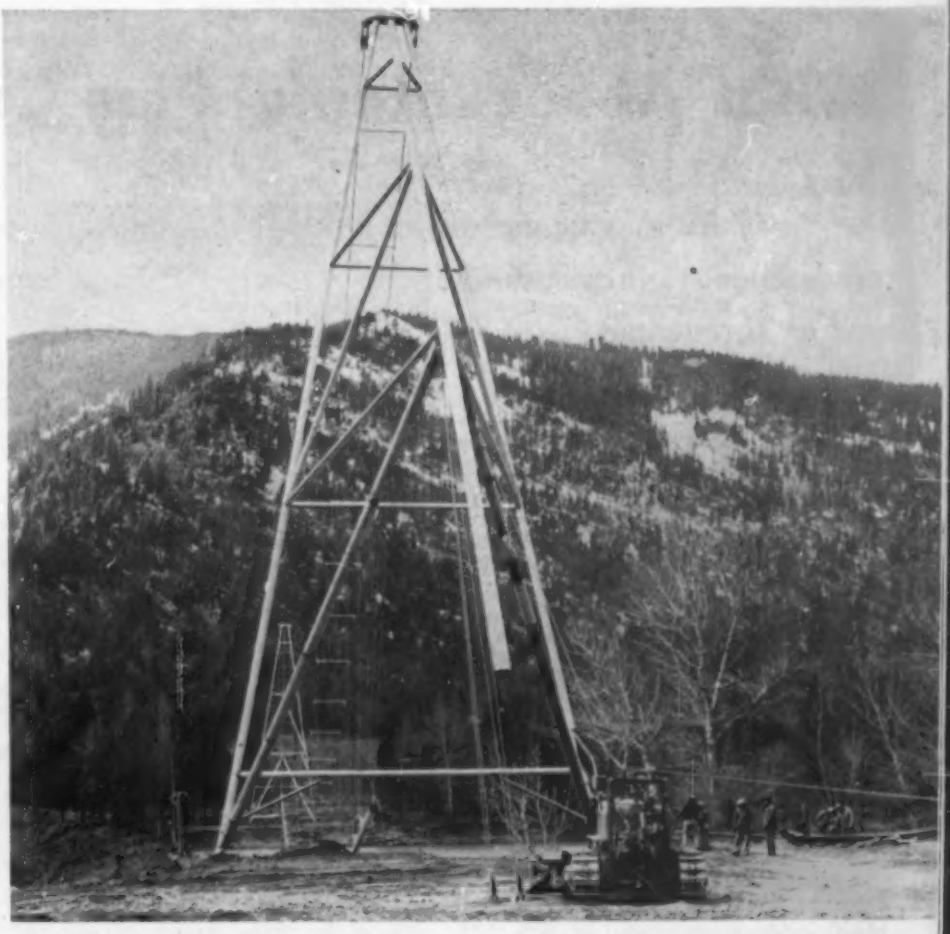
Erection of span. This operation almost has to be seen to be believed. Two tractors are spotted on opposite sides of the river near the bases of each tower. The winch lines are reeved through two blocks, one attached to the back leg of the tower, the other attached to the back footing. As the tractors winch in their lines, the towers swing into upright positions hoisting the bridge aloft. When the back legs reach the bearing plates on the footings, the bridge is checked for camber, etc. In most cases, little or no adjustment is necessary and the leg is welded to the bearing plate. However, it is possible to raise or lower the pipe, etc., by adjusting the length of the back leg.

Raising and lowering bridge. One of the most remarkable features of this design is that the entire bridge can be raised or lowered in an hour or so. For this reason, crews may halt the hoisting operations to lower the bridge to adjust suspenders, etc. Sometimes crews may lower the bridge back to water level just to make a trifling adjustment to some part of the bridge.

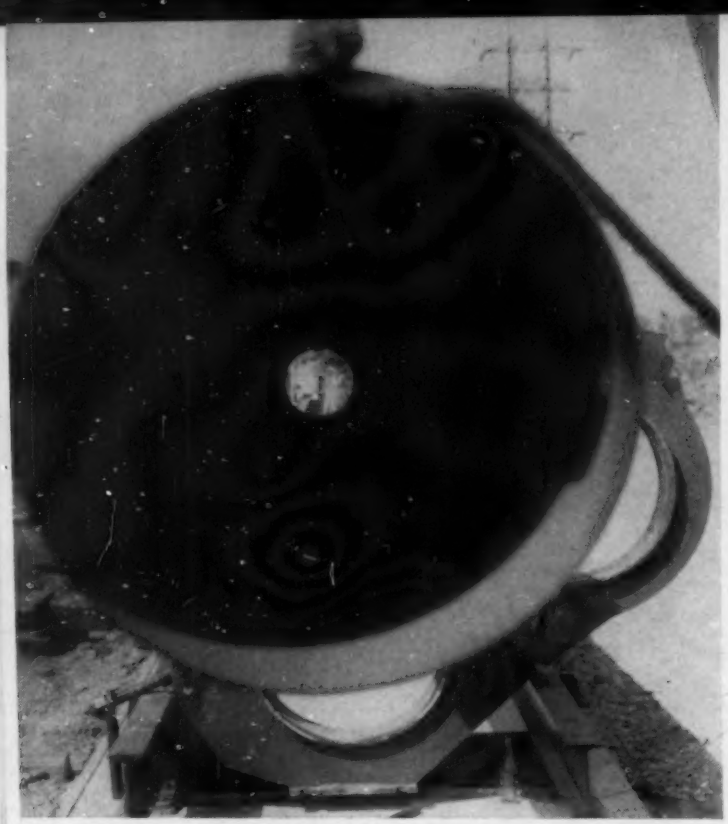
The Clear Span Engineering Company, as a subcontractor to the Associated Pipe Line Contractors, Inc., designed and constructed all seven of the bridges. Paul Robishaw was field engineer and construction superintendent for Clear Span. Robert E. Todd was special spread man for Associated. Herbert H. Hodgeman assisted in liaison between field and home office on operations. John R. Hays assisted in the design and managed the field layout of all locations. The development of these bridges is credited to Weldon F. Appelt, president of Clear Span. —**The End**



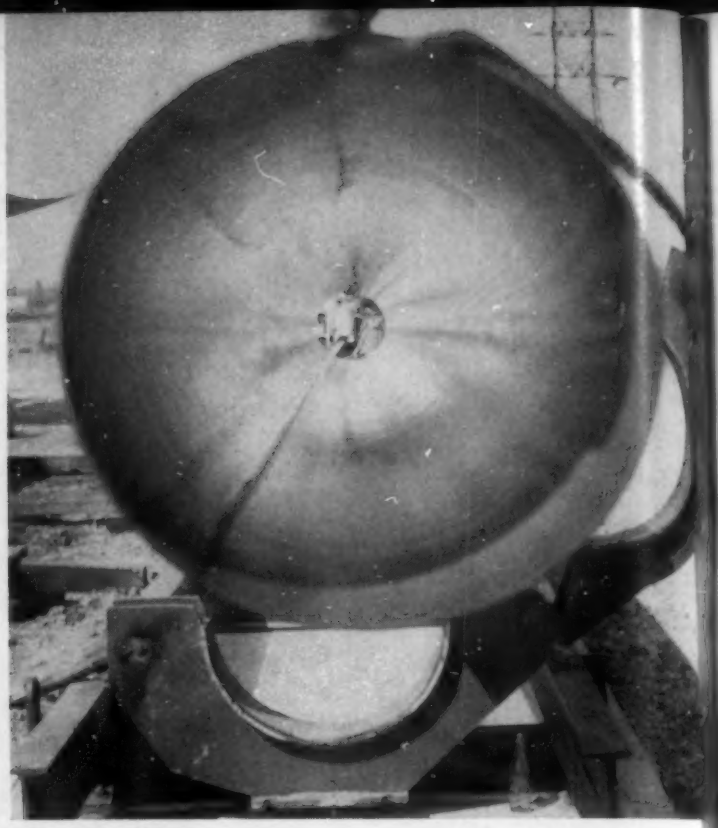
ACROSS THE RIVER. The pipe with its burden of wire rope is pulled across river on rubber rafts. Rafts slide along a wire rope which spans the river, affording control of pipe in river currents.



185-FOOT TOWER serves as gin pole to hoist the aerial span into final position. Because of ease with which the span can be raised or lowered, construction crews often raise or lower pipe several times before tieing the tower permanently to foundation.



BEFORE Interior of the pipe is coated with mill scale and rust caused by seven-months' storage near salt water. The combination coating and cleaning machine removes as much as a quart of rust from inside of pipe before epon resin is applied.



AFTER The cleaning and coating machine makes two passes in and out of the pipe, whirling as it goes. As the machine is retracted from pipe on its last run, three spray nozzles apply the resin. The result is pictured above.

What About Internal Pipe Coating?

It may be the answer to rouge in products lines . . . internal corrosion in sour crude lines . . . dust and mill scale in gas lines. Improved friction factor may mean greater throughput.

By FRANK E. HANGS, Chief Design Engineer, CRC Engineering Company, Houston.

PROCESSES FOR cleaning and coating the outside of pipe have been highly developed and extensively used by the pipe line industry. Cement and coal tar have been used for more than a 100 years in coating the interior surface of concrete and cast iron water mains. However, not much has been done toward cleaning and coating the inside of the larger diameter lines used in gas transmission, petroleum and product service. Chemical plants and refineries use various interior coatings such as cement, glass, rubber and certain types of plastics in corrosive services.

Baked on coatings are used for oil well tubing and casing in sour crude wells. During the last three or four years a process of cleaning, priming and plastic coating the inside of gathering lines in sour crude service has been used in West Texas. Sections of line are treated in place utilizing compressed air driven plugs in a patented process.[1] While not very many miles of pipe have been so treated, preliminary results are encouraging.

In corrosive service in refineries, chemical plants and in small sour crude systems a relatively expensive internal coating can be justified. This is not so in large diameter gas, crude or products lines. Internal corrosion damage in normal trunk pipe line service, while troublesome, is not as critical as in plant utility lines or sour crude gathering lines.

Some advantages of cleaning and coating the interior of pipe for a gas, crude or products line are as follows:

Pipe stockpiled for considerable periods of time in the open will deteriorate rapidly, especially in humid climates. By yard coating the interior and priming the exterior, this deterioration could be greatly reduced. In the ideal situation the pipe should be cleaned and coated at the mill as soon after rolling as possible.

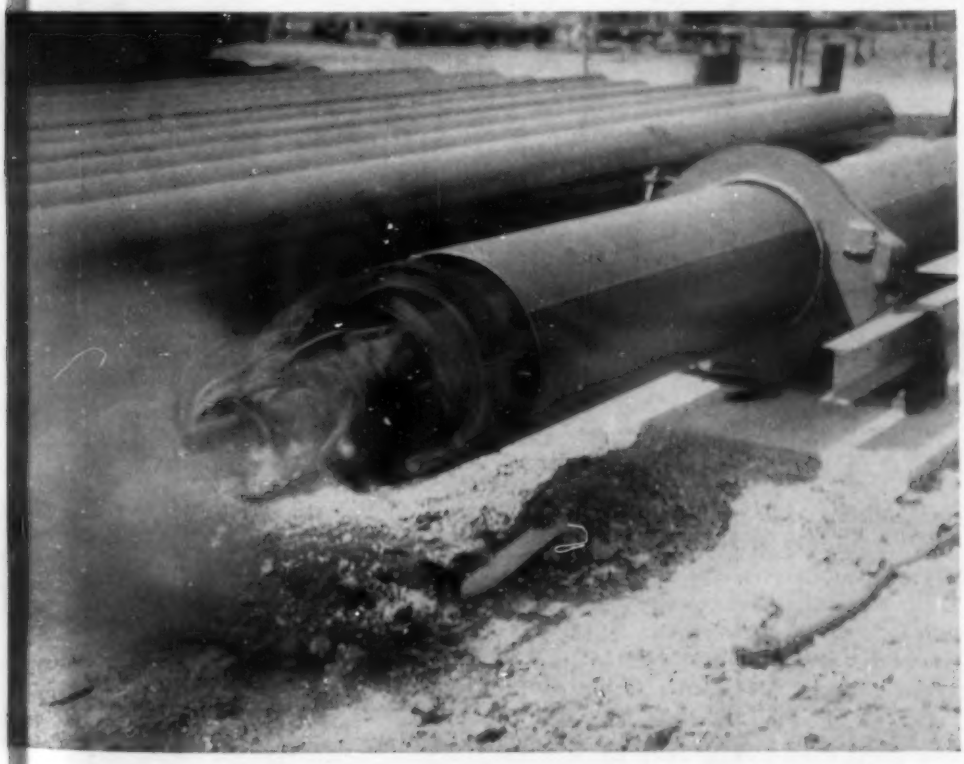
A good internal coating would protect the metal on the inside of the pipe and present a comparatively

smooth surface to the fluid. Rust and other products of corrosion in pipe lines reduce the effective wall thickness, and since these materials are also abrasive, special equipment such as scrubbers and strainers is required to remove tons of material each year from pipe line systems.

To reduce the amount of these corrosion products would, in itself, be a very real advantage in pipe line operation. Because of internal corrosion in gas and products lines, it becomes necessary to take preventative measures. Gas companies dehydrate while products companies use inhibitors extensively and dehydration to a limited degree. Unfortunately, these measures are not totally effective and many pipe line companies find it necessary to clean their lines from time to time to maintain efficiency and throughput. It can be seen that an effective internal coating, protecting the metal, would do much to sustain the efficiency of a pipe line system, whereas the efficiency of uncoated lines is known to progressively deteriorate.

OVER-ALL VIEW of the new internal pipe coating machine. By changing pigs on machine, it can be used to coat pipe ranging from 6 to 36 inches in diameter.

A discussion of "roughness" and "efficiency" of pipe lines would be largely speculative in this article. These terms are more or less relative but are a useful measure of the performance of a given pipe line at different times. The Hazen-Williams formula, used in designing many products pipe lines, embodies "C" or roughness factor. The Panhandle formula, so widely employed in the gas transmission industry, incorporates an efficiency factor. In both formulae, for a given pipe line with a specific pressure drop, the quantity of fluid or gas which will flow in a unit of time is directly proportional to the "C" factor or the efficiency. This is significant, since any improvement in the "C" factor of efficiency is immediately reflected in improved performance of the pipe line system.



INTERNAL COATING DEVICE IN ACTION. Steel brushes similar to those on a pig polish the pipe to mirror-like finish before coating is applied.

Effectiveness. Naturally, pipe line designers and operators will want to know the effectiveness of internal pipe line coating, how long it will last and the cost of application. Unfortunately, these questions cannot be answered with satisfactory definitiveness at this time. It can be said, however, that this internal coating process offers several interesting new possibilities for improving pipe line operations. It is anticipated that one or two pipe line companies will have some pipe internally coated this year for test purposes and that reliable data will be available by the middle of 1955.

If the proper coating increased the efficiency of a large gas transmission system by a percent or two, the added revenue could readily approach a million dollars annually and thus justify the cost of application. Also, if a relatively high efficiency were main-

Continued on Page 112

What's Ahead in Cathodic Protection?

Steel anodes . . . calcium alloy anodes . . . solar or atomic batteries? Here are some ideas on future developments and trends in this field.

By **MARSHALL E. PARKER,** Consulting Corrosion Engineer, Houston.

WHAT NEW developments does the future hold for the application of cathodic protection to pipe lines? Some trends are now visible, some are probably developing but not yet noticed, and, in all probability, there are many distinct surprises in store. Certainly there are some interesting possibilities which have not been adequately explored. Much of the following discussion is highly speculative, and some of it may even be called fantastic.

Sources of power. Cathodic protection systems in present use fall into two broad categories; those using galvanic anodes, and those using an external source of direct current, introduced into the earth through an inactive anode. Direct current for use in the latter system has in the past been obtained from engine-driven generators, from windmills, and from rectified commercial a-c power; the latter source is dominant at the present time.

The use of generators, either engine- or wind-driven, has decreased from its former popularity largely because of the wide-spread development in rural power lines. Too, the improvement in pipe coatings has made possible wider spacing and smaller units, which makes it easier to find locations where power is available.

Two kinds of future development may be anticipated; improvements in rectifier design and construction, and the development of new sources of direct current. Selenium has virtually displaced copper oxide as a rectifying material; germanium and silicon posses similar properteis, many advantages, but have not yet developed into commercial units in the ratings needed. Undoubtedly there are still other materials which might serve. So far as the writer knows, there has been no attempt to produce an electrolytic rectifier—of which there are several varieties— for cathodic protection service. Electronic, or vacuum tube rectifiers, have been usefully employed in units much smaller or much larger than those used for cathodic protection, but have had only very minor application in this field.

Another type of rectifier has been successfully used in other fields, and is the object of a development program at present for cathodic protection—the mechanical rectifier, in which a synchronously driven mechanism simply reverses connections at the proper intervals, so that the direction of current flow in the output circuit is the same at all times. The principle is simple, but the mechanical details require careful attention; properly designed, such a unit should have a very high efficiency.

There are many possible ways of generating direct current; the conventional rotary d-c generator, coupled to a prime mover, has already been mentioned. Others are known, and many are in use in other fields. Direct current can be obtained from primary cells; in effect, this is what is being done now in the use of galvanic anodes, but this type is to be discussed later. A primary cell can be built and connected between the pipeline to be protected and an inactive anode, just as a rectifier is connected.

At least one such installation has been made, using a zinc-salt water-

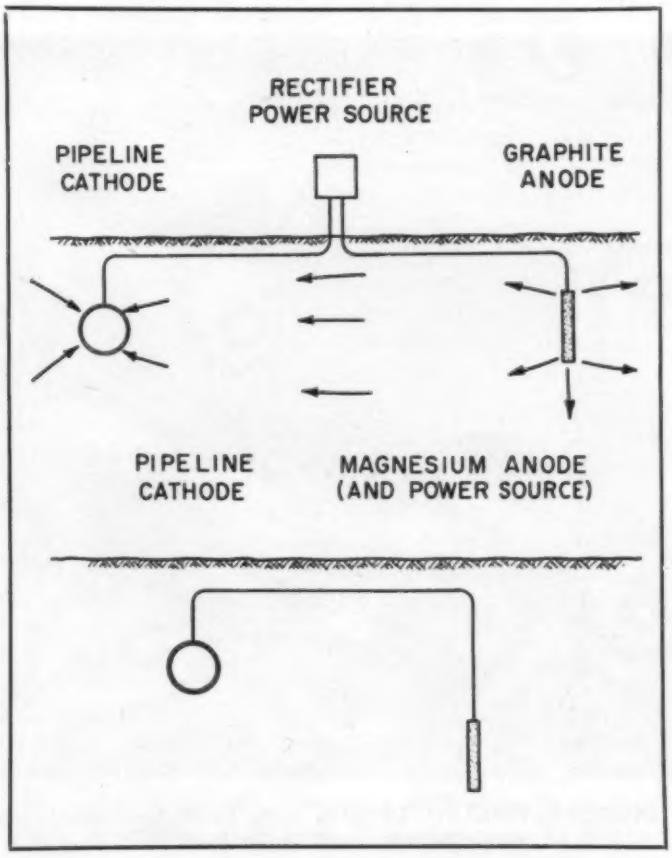


FIGURE 1

steel cell (Figure 2); this was a very special case, however, and the principal reason for this system was to obtain a very low-resistance path to earth for the pipe (a pipe-type power cable) while at the same time maintaining it at a cathodic potential. It is not too difficult to imagine, however, a situation combining soil resistivity too high for galvanic anodes with non-availability of power lines, in which a battery of primary cells could be built to supply cathodic protection current for a pipe line. Storage batteries could be similarly used; at least one is in service, but again the chief consideration was obtaining a very low-resistance ground on a pipe-type power cable. It is not inconceivable, however, that a set of storage-battery powered cathodic units along a pipe line could be serviced at intervals with a portable generator for charging; certainly storage batteries have been very useful in temporary cathodic protection for testing purposes.

Current-generating thermocouples have been tried for cathodic protection, using fuel drawn directly from the (gas) pipe line. Mechanical difficulties and high initial costs have not, as yet, been successfully overcome. So far as can be ascertained, no effort has been made to utilize solar energy by means of thermocouples; such devices are of micro-watt size. The same is true of a recently announced "battery" which converts radiant energy (sunshine) directly into current; the device is of microwatt rating.

The so-called "atomic" battery is another source falling in this category. It must be remembered, though, that some of the first generators built, heavy, bulky, and requiring considerable power, produced only a few feeble and useless sparks. There exist at least three other "effects" in which an electric current or potential is generated; none of these seem to offer any commercial promise, even with the wildest imagining.

The Nernst Effect, in which the flow of heat across a magnetic field gives rise to a potential at right angles to both.

The piezo-electric effect, whereby mechanical strain on certain crystals produces a potential.

The Thompson Effect, by which a temperature gradient along a conductor is accompanied by a potential gradient also.

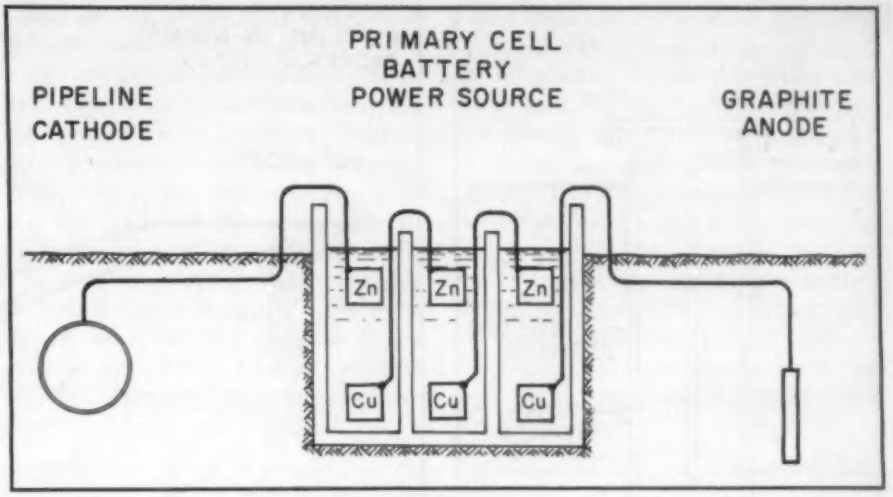


FIGURE 2

Anodes for impressed current. Formerly the most common material for anodes used with impressed current systems was scrap iron or steel. Many pipe line companies used scrap pipe, and, in fact, its use is still fairly common. Such anodes are consumed by the current discharge, and must eventually be replaced. Cast iron is consumed at a somewhat slower rate than steel, particularly if the current density is low, and may continue to function as a carbon anode after much of the iron is gone. Two factors have combined to reduce the use of iron or steel anodes; the price of scrap steel is much higher than formerly, and the more widespread application of cathodic protection has meant that pipe line companies often no longer have any substantial quantities of scrap pipe.

The graphite anode, installed in a backfill of coke breeze, is almost a standard anode today, but its position is not unchallenged.

Alkali anodes have been used; these consist of small-diameter black iron rods or pipes, suspended in a concentrated solution of caustic. The solution is contained in a porous cylinder or pipe set in the ground. As long as the current density and the caustic concentration are both kept high, there is no consumption of the iron; the passage of the current produces decomposition of the caustic, which must be renewed periodically.

Aluminum anodes have been used under special circumstances; these have usually been scrap available at extremely low prices, or very large ingots used close to the point of production, and then only in very favorable circumstances. It should be pointed out that in the application of cathodic protection to the interior wetted surfaces of water tanks, aluminum is frequently the anode material of choice.

Its advantages in this application are: its light weight and superior strength, as compared to graphite; its lower electrochemical equivalent and the fact that its corrosion products are colorless, non-toxic, and non-staining, as compared to steel; and the ease with which, in sheet form, it can be fabricated into anodes with large area-weight ratios, for use in high resistivity water.

Anodes of a high silicon cast iron, which have recently been developed, offer promise, when used more or less as graphite rods are used. Tests and experiments, some concluded and others now in progress, indicate the possibility of high current density without appreciable solution of anode material, and there is some indication that good results can be obtained without special backfill. If this develops as indicated, it offers an opportunity to make substantial savings in installation costs, particularly in low marshy areas, where proper tamping of backfill around graphite anodes is always a problem. Although brittle as compared to steel, these anodes are much less fragile than graphite, and in some soils might very well be pushed or driven into place.

Galvanic anodes. Zinc was the first galvanic anode material applied to

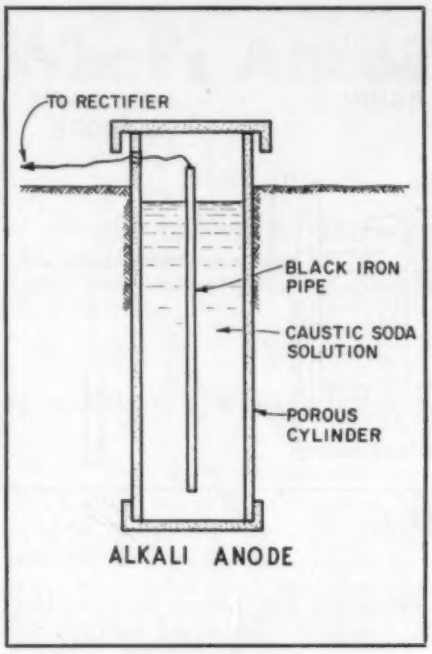


FIGURE 3

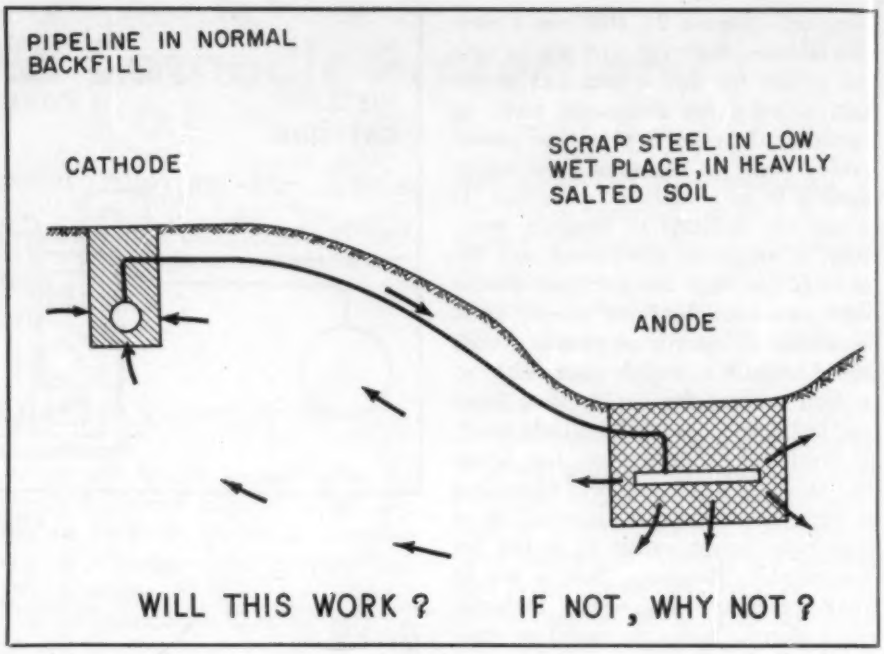

PIPELINE IN NORMAL BACKFILL
CATHODE
SCRAP STEEL IN LOW WET PLACE, IN HEAVILY SALTED SOIL
ANODE
WILL THIS WORK ?
IF NOT, WHY NOT ?

FIGURE 4

the cathodic protection of pipe lines. This was followed by magnesium, a development made possible by the lowering of production costs accompanying the expansion of facilities during World War II. For a time it seemed that zinc might be almost entirely supplanted, but recently its many advantages have come to be realized again, and its use is now on the increase.

For the immediate future, at least, it looks as if the two metals will continue to be very useful in this field. Some attempts have been made to develop techniques making aluminum useful as a galvanic anode, but its polarization properties have generally defeated these. Approximately 6 percent of the metal used as magnesium anodes is aluminum, the alloy having proved better for the purpose than pure magnesium.

Examination of the Electrochemical Series discloses only one other metal which seems to offer any possibilities at all in this application, calcium. It is higher (more active) than any of the three discussed; so active, in fact, that its use as substantially pure calcium is not feasible, since it reacts directly with water. At present the price of the metal is too high for consideration, but this was once true of magnesium. Perhaps as an alloy, calcium will some day be used as a galvanic anode.

One phenomenon, well known to pipe line corrosion engineers, has apparently not been investigated as a cathodic protection possibility. The ordinary course of uncontrolled corrosion on buried steel pipe takes place by electrolytic or galvanic activity between different parts of the steel surface; i.e., between anodic and cathodic areas. Clearly, then, it is not only possible, but extremely common, for steel to act as an anode with respect to steel; might it not be possible—and practical—under some conditions to construct some of the known types of cells in which the desired reaction takes place, arranging them so that the cathode is the pipe line and the anode is scrap or is otherwise expendable? Certainly steel, at 20 pounds per ampere-year, is cheaper than magnesium at 9 or zinc at 24, because of the large difference in metal cost.

It is known, for example, that a newly-laid steel line is anodic with respect to an old one; that steel from which oxygen is excluded is anodic to aerated steel; that portions of a line lying in low resistivity soil are usually anodic with respect to the remainder; and that steel encased in concrete is usually cathodic with respect to bare steel. Electrochemical theory, backed up by field trials, might be able to devise special environments for steel anodes which would give a dependable potential difference; the matter seems worth investigating.

System design. One trend discernible is cathodic protection system design is that toward smaller units. Two factors tend to bring this about; the improvements in coating materials and methods have decreased the total current demands, and growing interference problems have made it desirable to keep earth current densities low. The increase in power availability has also had a pronounced effect, in making it much easier to design with more and smaller units.

Another trend, due in part to similar factors, is toward more careful design for continuity of service. With better coatings, a smaller total part of the cost to the pipe line system is spent on cathodic protection, and relatively small increases in this budget can go into better and more careful construction. The smaller number of units required on a well-coated line can also be given better supervision and maintenance, and can, in general, be located at more readily accessible sites.

The trend is toward spending more dollars per ampere of current, but, because of the much smaller requirement with good coating, this can mean fewer dollars per mile of pipe. It is clearly possible to justify a more careful, and more expensive, installation for a single magnesium anode which protects two miles of pipe line than for the same anode, one of hundreds, each protecting a few feet of bare pipe.

The same attitude and conditions have led to increased emphasis on in-

strumentation to monitor protected structures, either automatically or with only routine attention. Further developments along this line are to be expected.

Many joint systems are being installed. This type of cooperative effort is principally effective where there are two or more lines on a common right-of-way. A joint system makes dealing with interference problems virtually automatic; the major question is a proper division of costs. This can usually be arrived at by agreement, based either on estimates or on actual measurement of current requirements; for a fully accurate solution, shunts can be installed to measure actual current division between the lines.

Often a system of this kind will be designed, in whole or in part, by an independent consultant. A possible future development of this idea is the establishment of a Cathodic Protection Authority—perhaps a corporation, jointly owned by a number of companies in a certain area, and supplying cathodic protection to all.

Influence of external factors. Developments in fields other than cathodic protection itself can profoundly influence it. As a past example, consider the wide-spread abandonment of electric street railways; what had been a stray current drainage problem became a cathodic protection problem. The increase in number of pipe lines has had, and will continue to have, influences in directions already mentioned. The same thing is true of improvements in pipe coating materials.

New pipe materials are being introduced. As plastic pipe enters, cathodic protection becomes unnecessary and impossible. The increase in the use of aluminum pipe brings with it many problems. Aluminum is an amorpheric metal, and thus subject to cathodic corrosion; the application of protection must be carefully regulated between narrow limits.

Also, aluminum behaves quite differently from steel when protection is intermittent or interrupted. With steel, there is a measure of protection even when the current is off for intervals. With aluminum, however, there is danger of serious attack on the metal by the alkalinized environment built up during protection. Continuity of service thus becomes of primary importance.

For the past 30 years or more, there have been tests and suggestions leading toward the construction of direct current power transmission systems. When and if this step is taken, there are likely to be some stray current problems of considerable magnitude.

Coating improvements have already been mentioned; they are likely to be important in another way also. If the general excellence of pipe coating material is greatly improved—and this seems highly likely to occur, probably by further developments in pastics—the effects on cathodic protection will be several. Much lower current requirements, with attendant changes in design approach, have been discussed. A quite different effect is the behavior, with respect to electrical and magnetic disturbances, of long lines with really superior coatings. Potentials are generated which can be quite hazardous to life and to property. The currents induced by such transients, usually taking the

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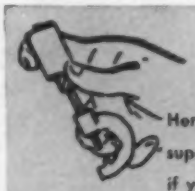

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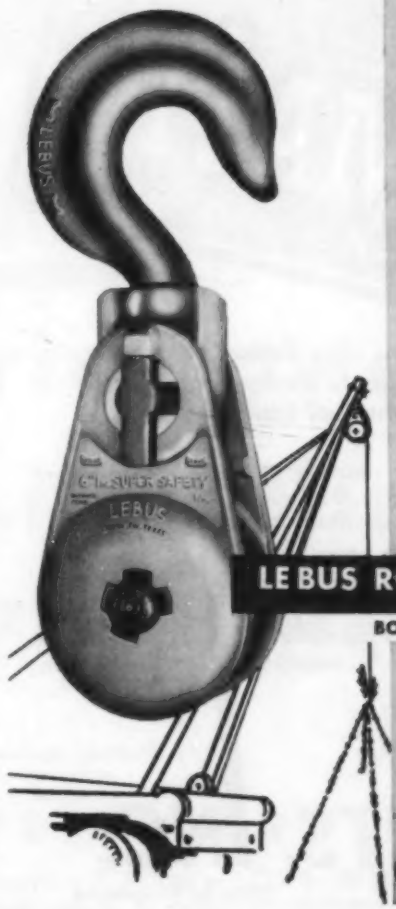

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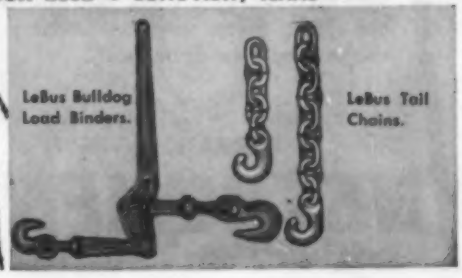

form of steep-front waves, will not be rapidly dissipated by attenuation as they are on most existing pipe lines; they will travel at high peak values, and may reflect significantly from insulated joints.

The only effective way to deal with such problems is by grounding the lines with relatively low impedance grounds. This means either one of two things (assuming that cathodic protection is to be maintained); either the use of unidirectional grounding devices, or the use of galvanic anodes for combined ground and protection. If the coating is extremely good, far more anodes would be required for grounding than are needed for protection—unless anodes of low driving voltage are available. Zinc looks attractive in this regard, and perhaps some of the possible steel anode cells discussed above might apply.

It is recognized that most of the above discussion is highly speculative. In fact, much of it might be described as fantastic. But is it not true that even today, the basic idea of cathodic protection itself sometimes sounds just a little bit weird? —**The End**

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Internal Pipe Coating

Continued from Page 107

tained over a period of several years with a minimum of cleaning, higher average deliverability could be maintained.

The coatings proposed for the interior of pipe lines have been successfully applied to preserve the inside of oil tanks for over a year with no apparent deterioration. It is estimated that quantity lots of new large diameter pipe can be yard cleaned and coated in one pass for approximately 15 cents per foot plus the cost of the paint. Of course, older pipe which has considerable rust will require more than one pass resulting in a somewhat higher unit cost. In trial runs, approximately three quarts of paint were used to put a two mil coat on a 40-foot joint of 24-inch pipe.

New Machine. Crutcher-Rolfs-Cummings, Inc. recently has developed a stationary or yard-type machine to wire brush and spray coat the inside of large diameter pipe. The joint being processed is held in place and the cleaning machine, driven by a diesel engine pushes the rotating head, which is mounted with wire brushes and spray nozzles, through the pipe. Air from a compressor, on the same carriage as the diesel, jets out the rust and foreign matter and supplies energy for the spray nozzles.

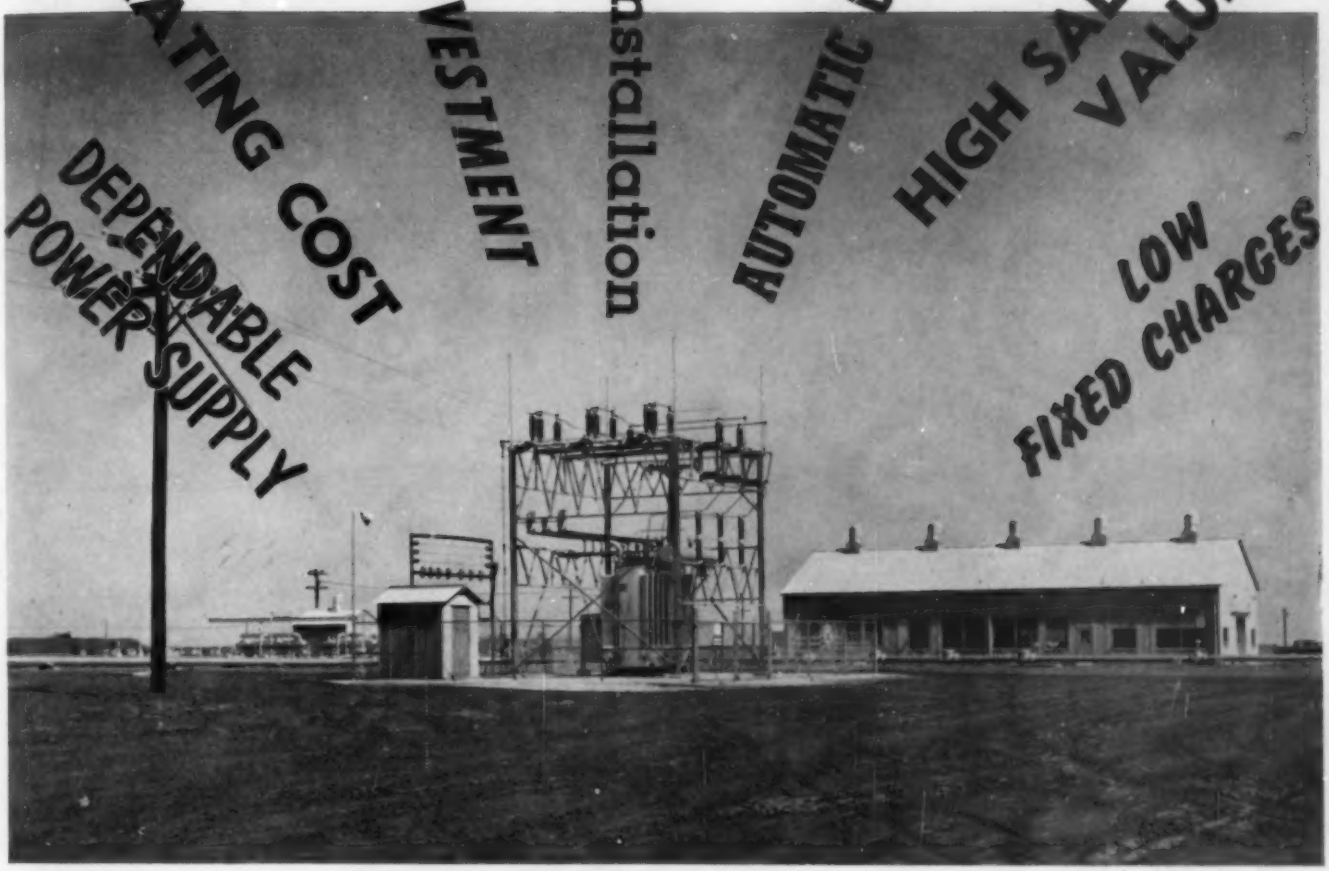
The coating for the inside of the pipe should possess the following characteristics: Be impervious to hydrocarbons and water; adhere well to the metal; resist abrasion; be sufficiently flexible and elastic after application to withstand normal handling of the pipe including bending; should be suitable for spray application and be air drying. Relatively new epon resins seem to fulfill most of the requirements outlined above. Representatives of the paint and the pipe line industries have indicated considerable interest and have expressed their willingness to make experimental applications of internal coatings.

The question proposed by the title of this article may be answered by actual application in the field within the next few months. The time may yet come when internal coating of pipe will be as commonplace as the external coating.

REFERENCE

K. Alfred, WORLD OIL, January, 1951.

—**The End**



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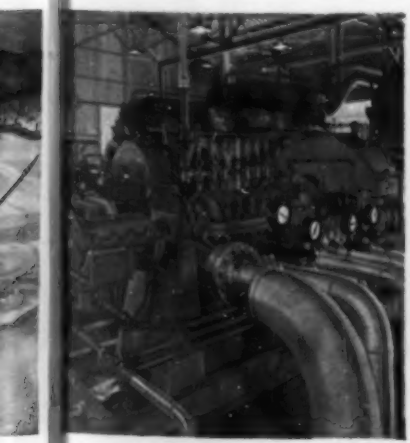
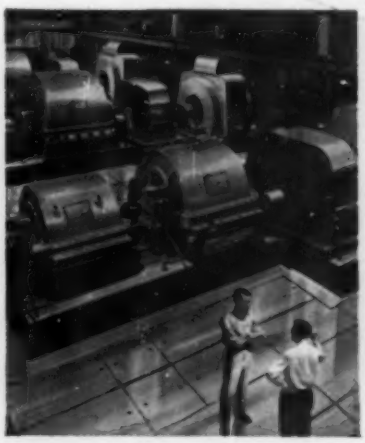


PACIFIC PUMPS, INC., Huntington Park, Calif. Centrifugal pumps, deep oilwell plunger pumps, hot oil and boiler feed pumps.



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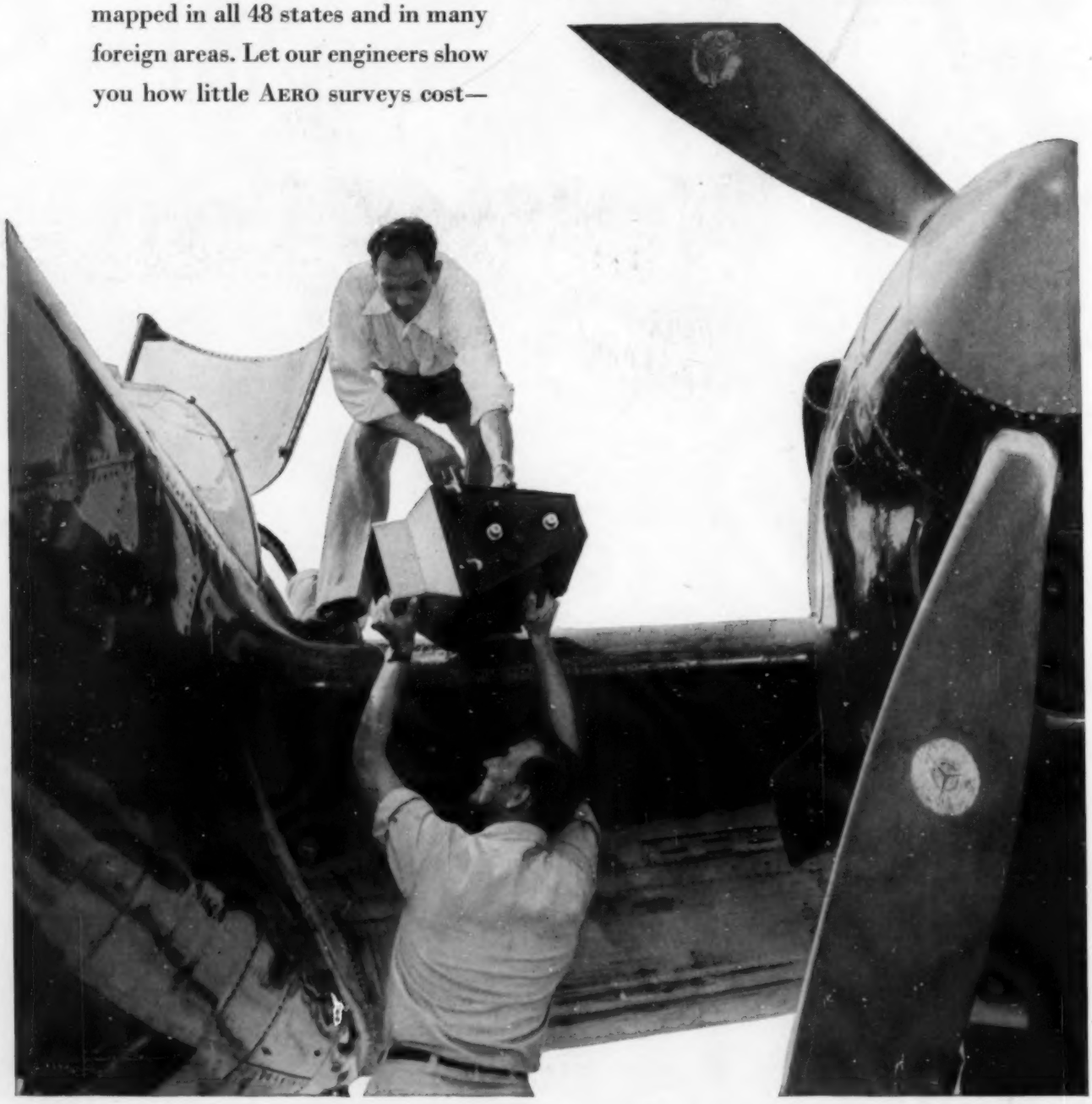


We asked engineers, superintendents and others: What are the qualifications of a good boss? Their answers may surprise you. Read this and learn . . .

What Employes Would Most Like to See in an Employer

By AL REESE, PIPE LINE INDUSTRY Staff

ANY SUPERVISOR in the pipe line industry, whether foreman or president, needs only one qualification to help forge an organization of loyal workers.

Authority for that is a cross-section of employes across the U. S. who replied to a PIPE LINE INDUSTRY questionnaire.

We asked the above cross-section of engineers, superintendents, foremen and miscellaneous workers: *"What six things would you most like to see in your boss?"*

They replied: "He doesn't need six qualifications. Just this one: Look upon me as an individual . . . a thinking, feeling being to be praised if you will, blamed if you must, but never ignored as a machination of nuts and bolts to be set in motion by pressing a button, with no explanation of WHY."

None of the replies were phrased in just those words, but the paraphrasing was unmistakable. The demand to be recognized as an individual, separate and apart from all others, headed virtually every list, and in some cases was reworded time and again. An example is a foreman's list of six things he would most like to see in his employer:

1. Personal interest in each individual as to his welfare.
2. Willingness to see a man get ahead.
3. Heck when we deserve it and likewise a pat on the back when we do a worthwhile job.
4. Tell us their future plans.
5. When changes are made, explain why.
6. A gentleman always worthy of his position.

Related qualifications. Such was the emphasis upon recognition of each employe as an individual that the other qualifications mentioned could only be interpreted as suggestions for exercising the all-important attribute. These suggestions fell into five broad categories.

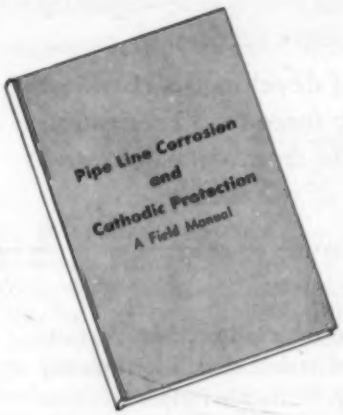
1. Good communications.
2. Proper delegation of authority.
3. Job knowledge.
4. Merit pay increases.
5. Fairness and firmness.

Among the miscellaneous workers, good communications were interpreted in terms of man-to-man contact. This group, thinking of the immediate supervisor, said a good employer should (1) make himself available always; and (2) occasionally review with each employe his work progress.

According to the foremen, the employer can realize good communications by:

- Explaining changes, whether of men, methods or material.
- Encouraging employes to suggest anything that might help the company, thus making communications a two-way street.
- Willingness to listen to his employes and to give help and encouragement where merited.

The superintendents and engineers evidenced a broader view of good communications. One superintendent said his boss should: "Keep me informed of details in my related work



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with other departments and operations that might affect public relations." An engineer declared: "An employer should keep his engineers informed on all matters of policy, whether affecting him directly or indirectly, except in those matters confidential to management."

The employes indicated that, in addition to drawing them closer to the boss, good communications are an aid to two other desirable attributes in their employers—proper delegation of authority and job knowledge.

Superintendents and engineers were particularly concerned with these qualifications in management, though sometimes for different reasons. The superintendents emphasized that the employer "should define your job in detail so that you can clearly understand your job and the scope of its responsibilities and authority." The engineers were more concerned with apportioning the work load in such a manner as to avoid burdening experienced personnel with minor details.

These two groups also emphasized somewhat different reasons for wanting greater job knowledge in their employers. The superintendents were interested in the employer having a knowledge of the job that would permit him to "make prompt decisions pertaining to operation, maintenance and capital expenditures." The engineers evidenced greater interest in such matters as "careful consideration of the practicality of design of equipment on new designs for pumping stations. Too many automatic devices are added without knowledge of the workability of the device from installation, maintenance or operating conditions."

These differences, however, were only in the matter of approach to a common goal. The survey left no doubt that the goal itself should be the creation of circumstances in which the employe can best serve his employer, thereby winning greater recognition for himself as a valued individual.

As to the manner in which that recognition should be bestowed, the groups were again divided as to emphasis. Returns from the miscellaneous workers and foremen were marked only infrequently with dollar signs, whereas the occasional "pat on the back" was considered of great

importance. In contrast, the superintendents and engineers were strong for merit pay increases. Since the foremen and miscellaneous workers are usually in close proximity to their immediate supervisors, whereas the engineers and superintendents work more remotely, this difference in opinion may indicate that applause, personally and enthusiastically administered, can sometimes be as important as money to the machine-age man intent on recognition as an individual.

Except when prefaced by the word "merit" the employes did not once mention pay increases, though there was a scattering of suggestions that fringe benefits are an excellent yardstick for measuring the employer's interest in his employes.

Urge to admire. Other attributes the employes said they would most like to see vested in their employer were commendable personal traits, of which those most often mentioned were fairness and firmness. The ability to "make a fair decision and stick to it" was cited in virtually every reply. Other such characteristics mentioned were:

- "An employer should be civic-minded, but he should perform his duties to the public and the company with as little as possible of blatant fanfare."

- "An employer should have the poise to make himself master of any situation and a show of optimism to inspire others."

- "An employer should have a sense of humor."

- "An employer should set a good example in all things which he expects of his employe."

All of which could be accepted as evidence that employes are happier, more productive, and therefore making greater progress toward personal recognition if their employer, symbol of the company in which they are investing their working lives, is deserving of their admiration, respect and pride. —The End

● Next month employers will describe the qualities they most like to see in their employes.

Right on the Line

WEST OF BILLINGS, MONTANA, on the Yellowstone Pipeline job, this CLEVELAND Model 320 Pipeline Trencher is digging its way up a 250 foot hill of layer rock at an angle of better than 30° after digging 4 miles of straight trench through a dry lake bed. Inspectors for the Lowery-Continental Oil Co. maintain this is the straightest 4 miles of trench they have ever seen.

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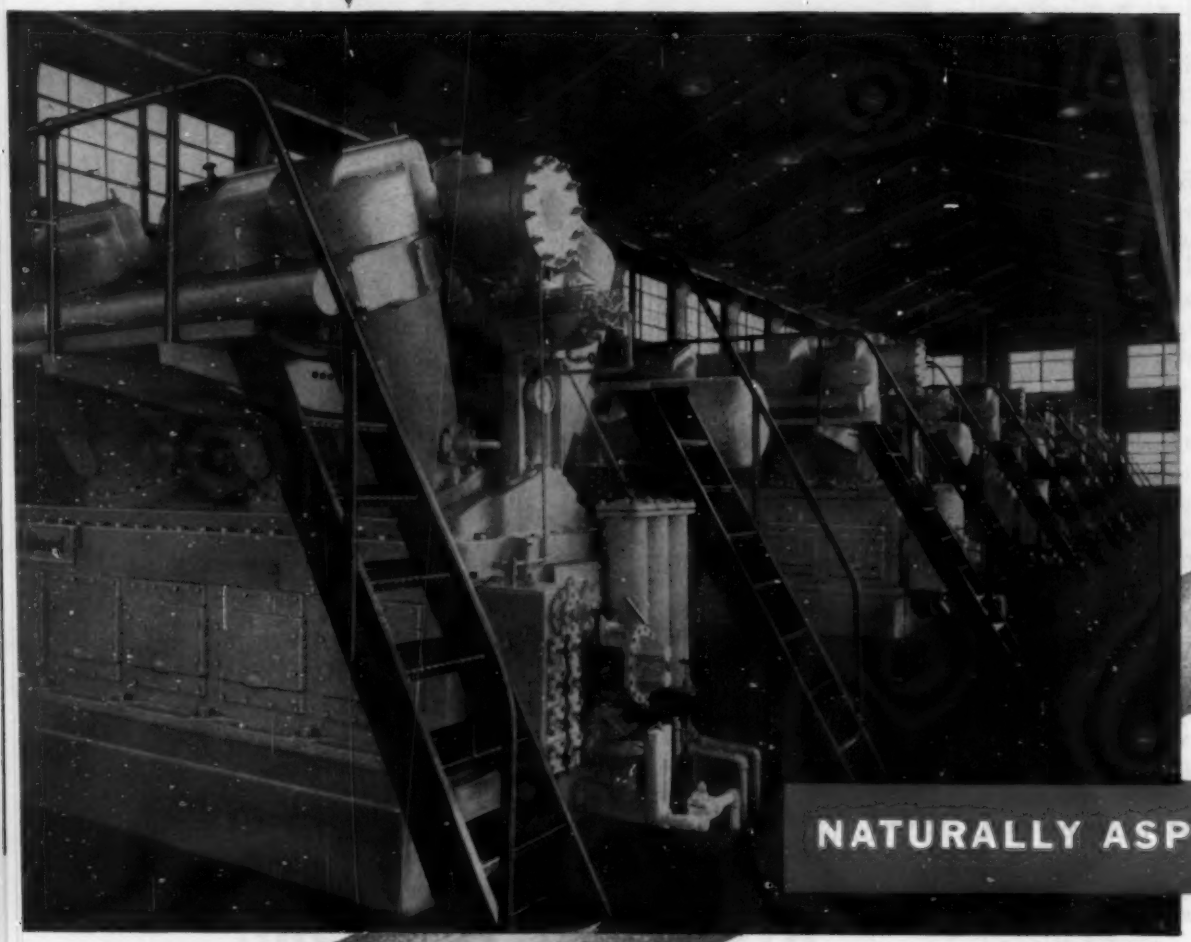
(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

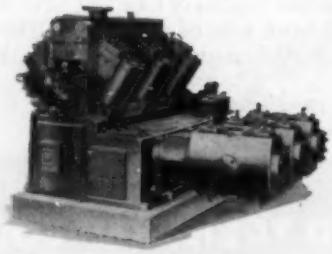
4-CYCLE GAS-ENGINE COMPRESSORS fo



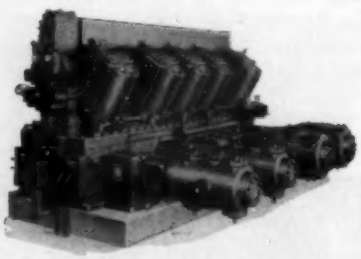
NATURALLY ASPIRATED

Six 1320-hp Ingersoll-Rand KVG gas-engine-driven compressors installed at a gas booster station in Texas serving a new 30-inch pipe line.

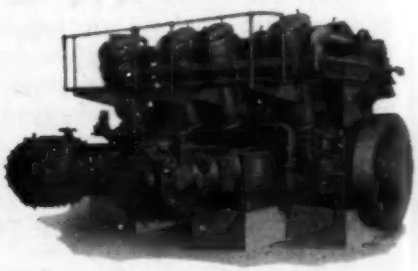
There's a Dependable IR *Unit for Every A*



JVG 110, 165 and 220 hp
Available with 4, 6 or 8 V-angle power cylinders and 2, 3 or 4 compressor frames.



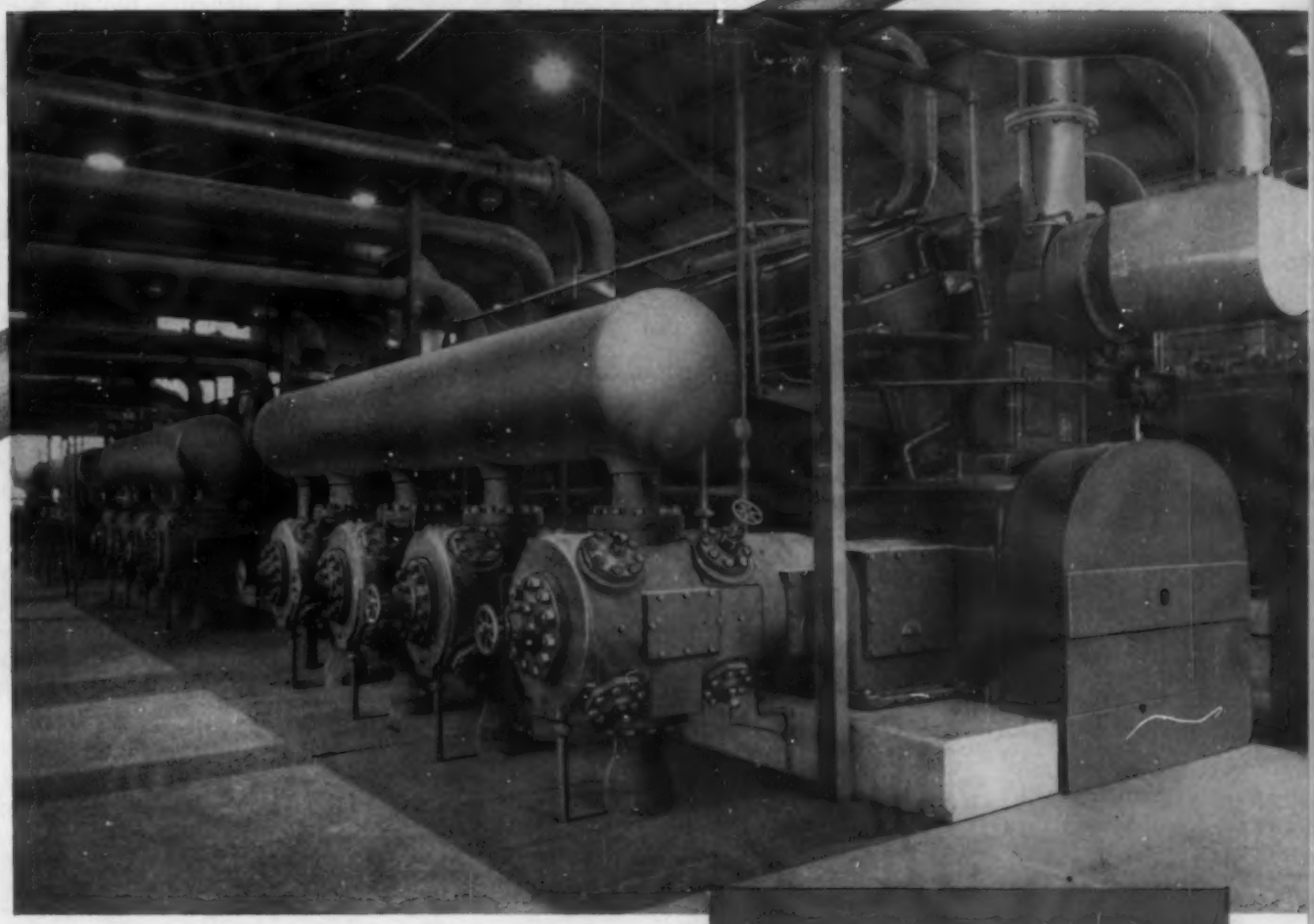
SVG 330, 440, 550 and 660 hp
Available with 6, 8, 10 or 12 V-angle power cylinders and 3 or 4 compressor frames.



KVG 660, 880, 1100 and 1320 hp
Available with 6, 8, 10 or 12 V-angle power cylinders and 2, 3 or 4 compressor frames.

Ingersoll-Rand companion 4-cycle gas engines are available to drive generators, pumps and other equipment.

for PIPE LINES



Seven Ingersoll-Rand 2000-hp KVS gas-engine-driven compressors at a natural gas pipe-line station in the Southwest—one of the first large-scale installations of the new Turbocharged unit.

TURBO-CHARGED

The KVS *Turbocharged* gas-engine-driven compressor gives Ingersoll-Rand a complete line of heavy-duty 4-cycle units from 110 to 2000-hp. In the 2000-hp KVS engine, dual exhaust-driven turbo-blowers provide intake air pressure for both scavenging and supercharging. Savings in space, weight, fuel and cooling equipment make this an important addition to the I-R line of V-angle, 4-cycle gas engines.

Whatever your pipe-line compressor requirements, Ingersoll-Rand can meet them from a *standard line*—with complete flexibility of compressor cylinder design and arrangement. With each size and type you get the traditional I-R *dependability* that means greater economies on a long-range basis. When planning *your* next installation, be sure to consult your Ingersoll-Rand representative. He can be of great help to you.

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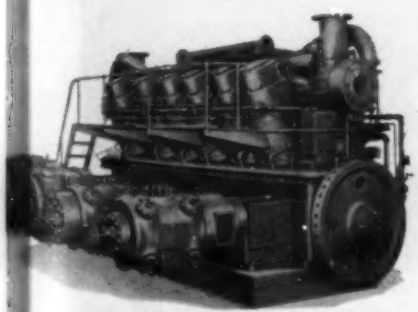

KVS 2000 hp—Turbocharged
Has 12 V-angle power cylinders and four compressor frames.

6-75

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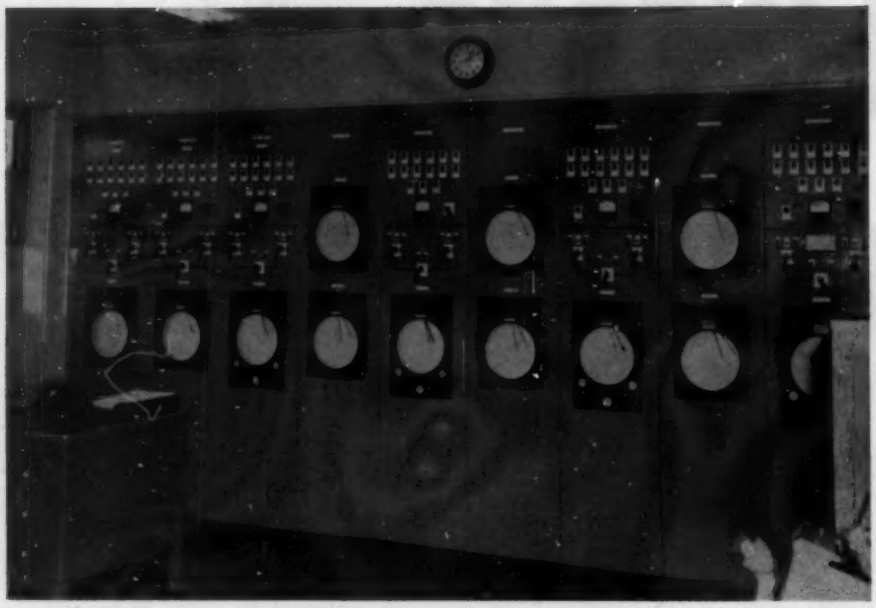

Fig. 1. Control panel for six-unit Station, Carrollton, Mo.

Adequate Controls With Emphasis on Simplicity

That's the trend in measurement and controls in pipe line operations.

By A. H. NEWBERG and C. E. SCHUSTER, Service Pipe Line Company, Tulsa

PIPE LINE OPERATING techniques have changed drastically with the advent of adequate control instrumentation. The economic advantages of fool-proof operation in emergencies is obvious. The use of automatic controls has reduced manpower requirements and helped eliminate the human error. By telemetering and supervisory systems, transmitted by telephone or microwave, stations can be remotely monitored and operated. Flow, pressure, temperature, and abnormal operating conditions can be checked from distant points. Sequence relay controllers permit pushbutton operation of units. Pressure and flow measurements are made with electric strain gauge pickups. Motor-operated valves are opened and closed automatically. Flow and pressure controllers now position discharge control valves to maintain suction and discharge pressures within set limits to maintain a constant flow. Automatic protective shutdown devices completely protect the station against abnormal or emergency conditions. The trend is to provide adequate controls with the emphasis on simplicity.

Communications. The need for a positive communication system for pipe line use is obvious. For years the telegraph and telephone have performed admirably, but are slowly being augmented by microwave. From its first pipe line application in 1949 covering 70 miles, it has grown to about 10,000 miles in 1953. The larger number of available circuits in a microwave system permits the use of VHF control, remote control of pump stations, and telemetering—all in addition to normal voice service.

Dispatching. Centralized coordination is a necessity for the complete control of all petroleum movements. By knowing the exact location of each batch of oil in the lines, necessary scheduling changes can be made swiftly and efficiently, assuring both the shipper and consignee of the maximum economical delivery with a minimum of commingling. The use of reliable communication facilities, telemetering, remote controls, and supervisory systems provide the dispatcher with effective tools to coordinate all operations.

Dispatching boards, a graphic and schematic reproduction of the pipe line systems using movable colored

Fig. 2. Control console and recording gauges, Bowie Station, Texas. Console has push buttons for starting and stopping units and controlling valves. It also has indicating lights for giving valve position, running condition, and protective shutdown causes, such as pump bearing temperature, seal leakage, case temperature, winding temperature, motor overload, and lube oil pressure. Pressure and flow recorders, pressure controller, and remote reading tank gauges are mounted on the vertical panels to right.

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On new construction we can fabricate and install a complete Fluor Pulsation Dampening Piping System that prevents compressor pipe vibration, at a price almost identical with that of a normal system of conventional piping.

How can we do it? Because we've been in the pipe dampening business a long time. We pioneered the use of piping systems based on scientific acoustical principles applied to fluid flow. We've learned from experience: since 1943 we've put into service 351 Fluor dampening installations throughout the world. We know that when we install a system we can guarantee it without equivocation. In plain words, we know our business.

To save time and costs on these jobs, Fluor maintains two well-equipped pipe fabricating shops—one at Los Angeles and one at Paola, Kansas. Fluor has perfected streamlined techniques for designing and building dampening systems—has the volume production to cut manufacturing costs—possesses the necessary experience to offer a better integrated unit at a price comparable with any normal system.

In addition to getting an economical "packaged" piping system free from vibration, you get many plus advantages in a Fluor designed system: more accurate flow measurement, lower maintenance costs, greater safety to personnel and elimination of vibrational stress on heat exchangers, vessels and related equipment. If the cost of a Fluor dampening piping system is measured by these advantages, then it is certainly one of the most economical buys in compressor plant equipment, today.

Fluor has something very definite to offer you—something far superior to any substitute method of reducing pulsation in pipe. Why not call us for an estimate and find out.

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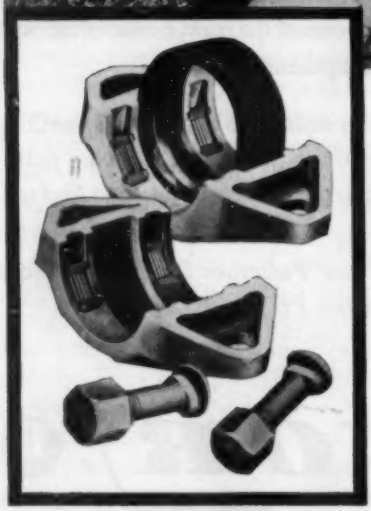
*U.S. Patents: 2,405,100—2,474,555—2,620,969

This unretouched photograph shows how expansion and contraction shifted the position of a surface petroleum line.



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And ROLAGRIPS offer all the other advantages of working with plain end pipe. No flanging, grooving, welding or threading. Easy to install. Easy to dismantle.

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For grooved pipe, specify GRUVAGRIPS — the coupling that's double ribbed for great strength with minimum weight.

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tapes to simulate the various oil batches, show the progress of the petroleum through the lines and provide an instant visual and mathematical check on all movements and operations.

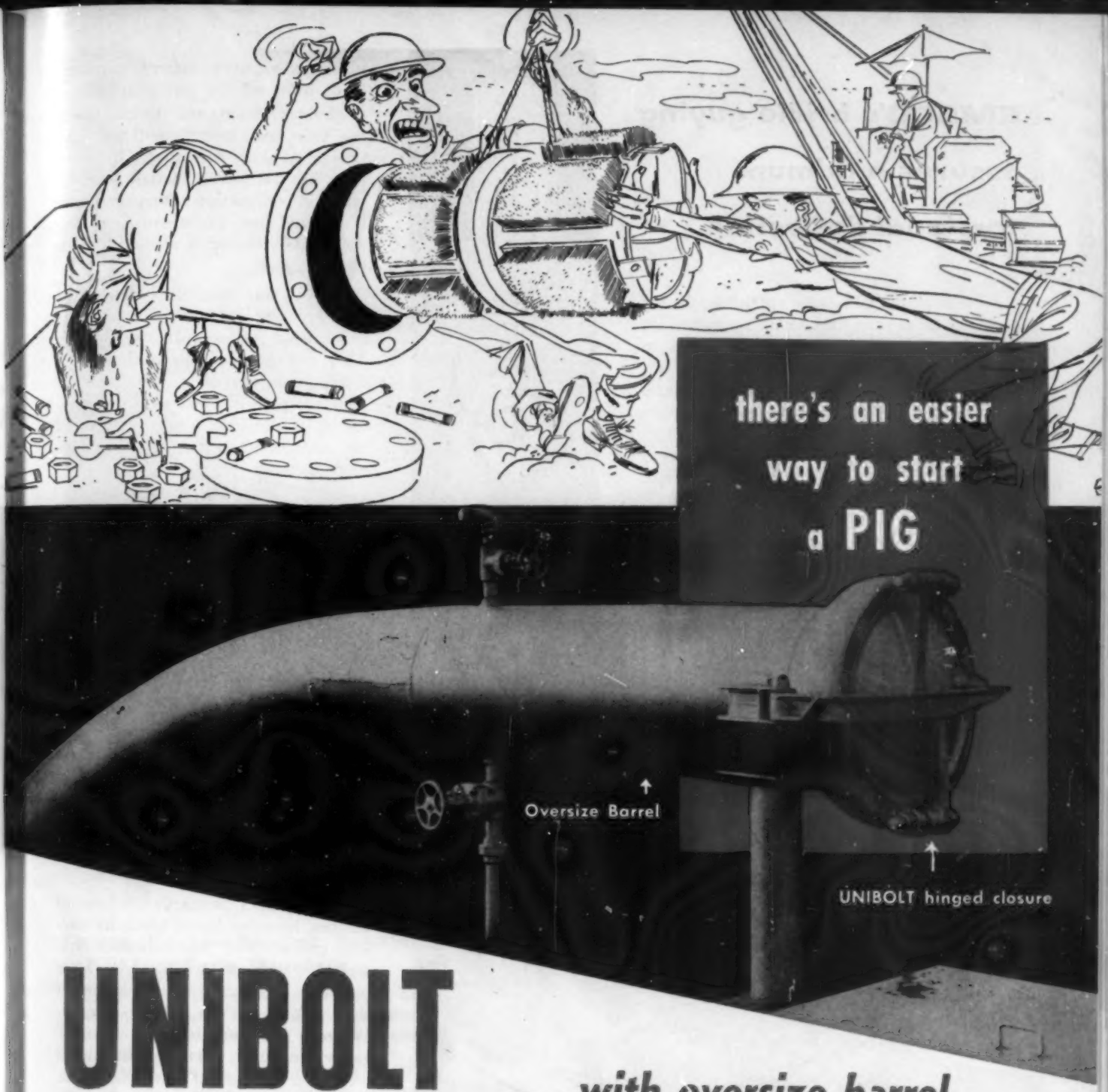
Radioactive Tracers. The use of gravitometers and radioactive tracers has made possible the positive location of the interface. The gravitometer gives a continuous record of the density of the passing oil stream and instantly indicates any variations in the gravity. Radioactive isotopes in the stream provide another method for locating the interface and allow instant detection through the walls of the pipe with the use of Geiger tubes.

The output of the tubes is fed to a rate meter and then to a recording instrument. These radioactive tracers also provide a novel means of starting and stopping automatic booster stations. The detection tubes are placed upstream from the station. The signal from the tubes is telemetered to the station to start and stop the pumps. The minute amount of radioactive material necessary and the resultant dilution in the stream remove all hazards to operating personnel.

Automatic samplers are used to obtain a representative composite sample of the various batches at reception and delivery points. These samples are normally used to determine the BS&W level and the gravity of the oil for custody transfer. Once set, these instruments operate automatically and meter a minute amount of crude oil into containers over a long period of time.

Fluid Flow. With the advent of the larger diameter lines, an accurate knowledge of flow characteristics is imperative. Since the sizing of lines, machinery, pumps, and other equipment is dependent on the initial theoretical hydraulic study, accurate evaluation is a "must" for economical design.

Extensive investigations into the transportation of heavy viscous crudes have developed ingenious methods of heating the pipe lines with electricity or steam. Injection of casinghead gasoline and other light hydrocarbons into the crude-oil stream has helped to reduce pumping power requirements. Control of the mixture is pro-



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Wherever multi-bolt flanged couplings and closures are now being used . . . on strainers, scrubbers, mist removers, terminal manifolds, blowdowns or other pressure vessels . . . UNIBOLT Couplings will serve you better.

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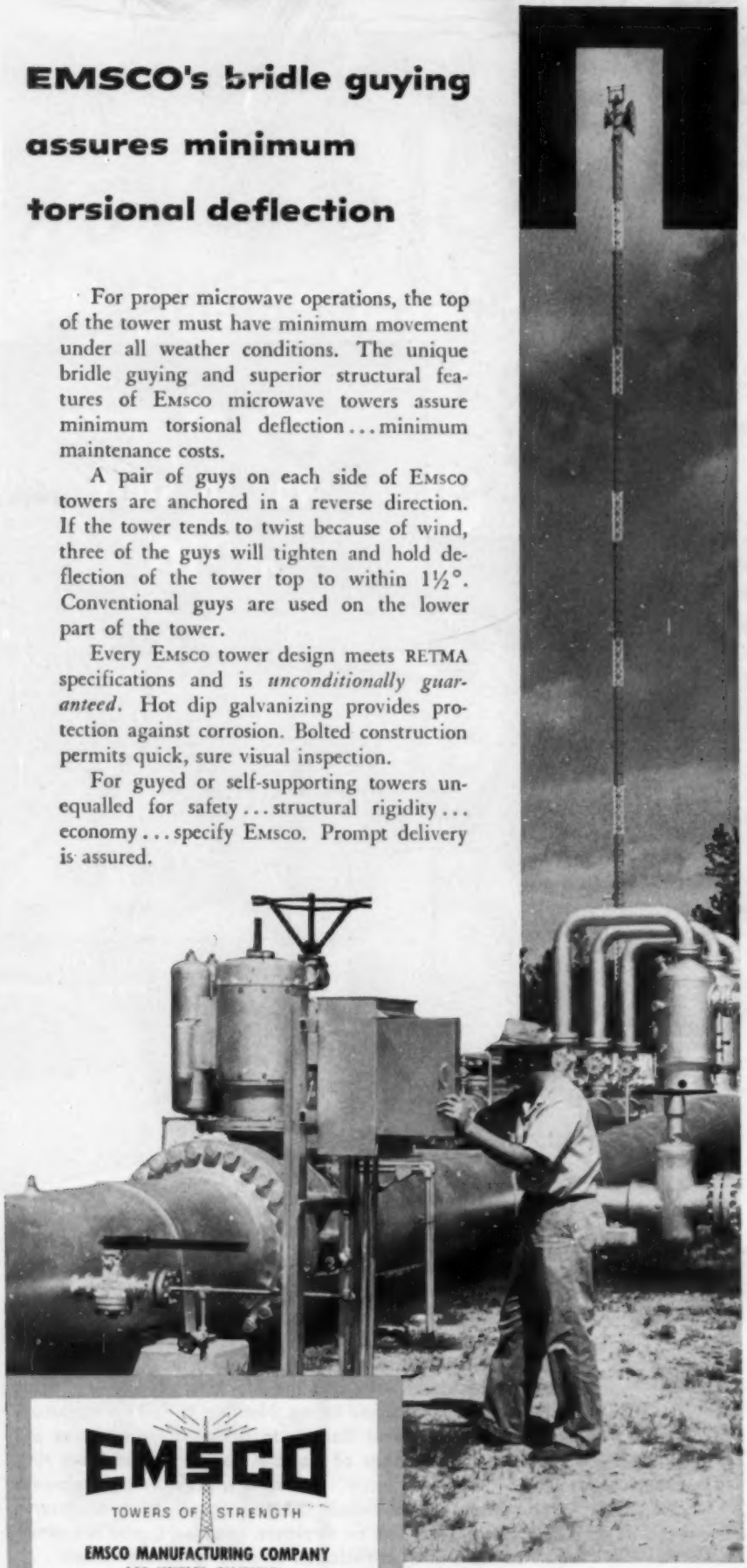
A pair of guys on each side of Emsco towers are anchored in a reverse direction. If the tower tends to twist because of wind, three of the guys will tighten and hold deflection of the tower top to within 1½°. Conventional guys are used on the lower part of the tower.

Every Emsco tower design meets RETMA specifications and is *unconditionally guaranteed*. Hot dip galvanizing provides protection against corrosion. Bolted construction permits quick, sure visual inspection.

For guyed or self-supporting towers unequalled for safety . . . structural rigidity . . . economy . . . specify Emsco. Prompt delivery is assured.



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Typical Emsco microwave installation Barton, Alabama

E-184

vided by vapor pressure recorders. With some of the extreme viscous crudes, visbreaking and thermal cracking have been investigated and have proved partially successful. One company has patented a method whereby water in conjunction with an inhibitor is injected into the stream, reducing the crude viscosity to one-tenth of its former value.

A new analytical tool called the McIlroy pipe line network analyzer is being used for network calculations. This unit enables flow and pressure distribution analysis to be made of complex pipe line net works in one-eighth of the time normally required by established numerical trial-and-error methods.

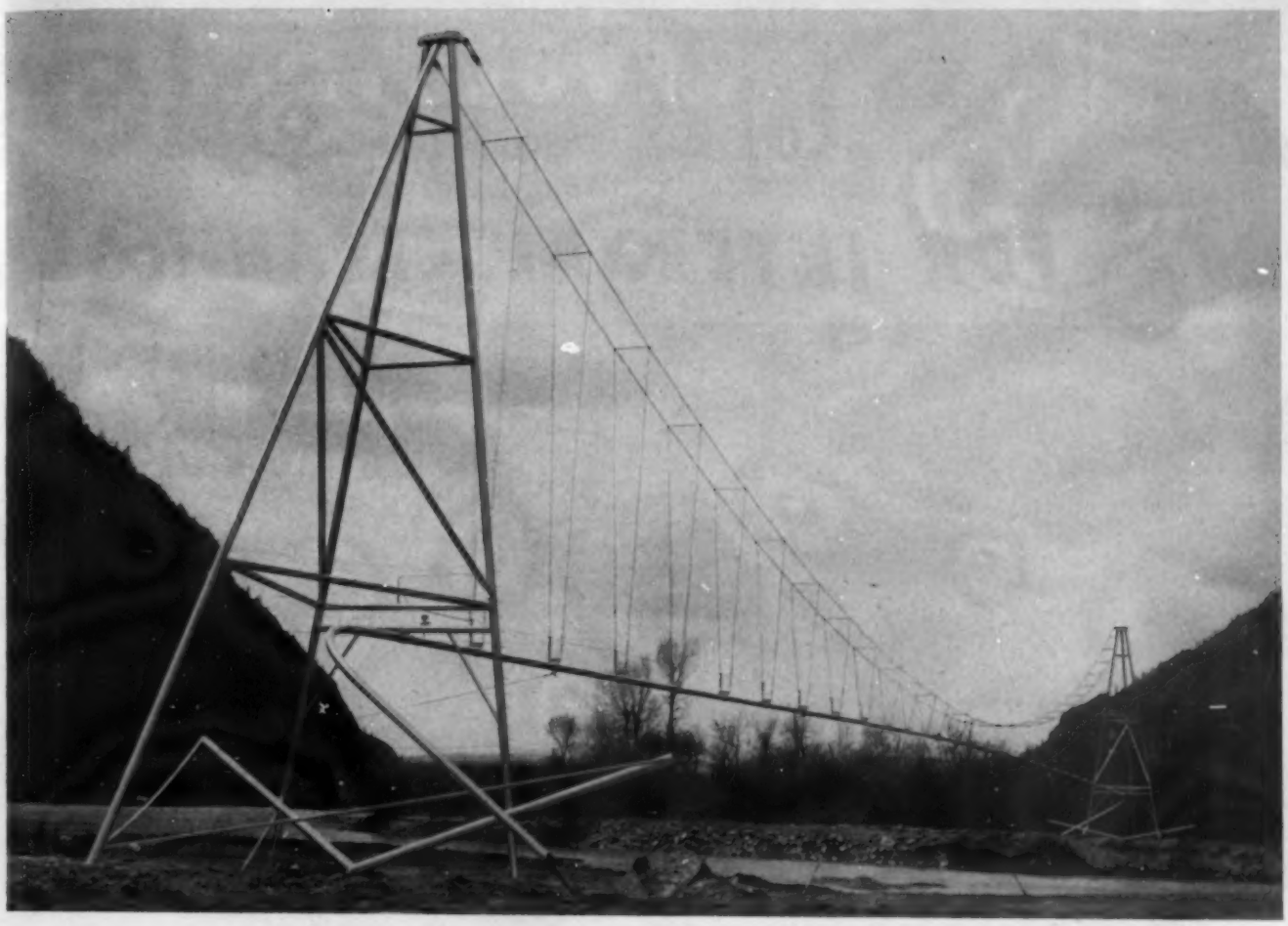
Measurement. Recent years have witnessed the widespread acceptance of automatic measuring devices on many pipeline systems.

The various committees of the ASME, API, ASTM, and others have done a tremendous task in evaluating and standardizing equipment and procedures, as well as in developing acceptable codes.

Tank Gauges. The automatic tank gauge with its associated remote transmission system has gained widespread use and has been adopted by the oil industry for buying and selling crude oil on a mutual agreement basis.

These gauges, primarily mechanical devices, measure liquid levels by various means. The float-actuated type and the surface-scanning type have probably received greater attention than most of the other gauges. Whereas the float-actuated type of gauge measures a change in liquid level as a function of float travel, the surface-scanning gauge uses an electric sensing element which detects changes in liquid level by an unbalanced electric circuit. With the use of a remote transmission system, these gauges can be read at distant points removed from the tank.

Many oil volume measurements are made with the use of positive displacement meters. With the new designs and procedures developed in the last few years, the PD meter has been accepted to measure liquid hydrocarbons accurately. The joint ASME-API Committee on Volumeter Research has established a code of recommended practices which is under



7 CLEAR SPAN PIPE LINE BRIDGES on YELLOWSTONE PIPE LINE CO. Line in Northwestern Montana . .

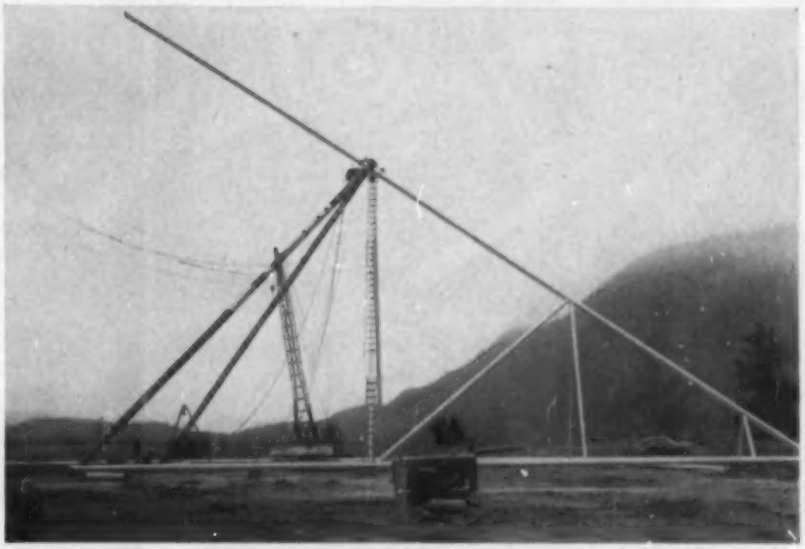
Lower Cost—Quicker Erection for Better Type Structure

Clear Span's patented pipe line spans are effecting substantial savings in pipe line construction wherever there are streams, ravines and chasms to cross.

The tripod towers are fabricated on the ground, saving money and time on erection costs. They are hoisted in place on prepared concrete footings, with main supporting cable, suspension cables AND PIPE LINE, secured to towers and raised into position along with the towers.

These Clear Span bridges on the Yellowstone line range in length from 431 feet to 1205 feet. They can be erected in clear spans as long as 2000 feet . . . to carry any load, anywhere.

Savings on river crossings run as high as 30%, with Clear Span pipe line bridges.



• Close-up of tripod tower on ground, ready to be raised. With main cables strung, and suspension cables in place, pipe line will be pulled into suspended position as towers are raised.

CLEAR SPAN BRIDGE & BARGE CO., INC.

11th Floor Prudential Bldg., Houston, Tex.
Telephone KE-1940

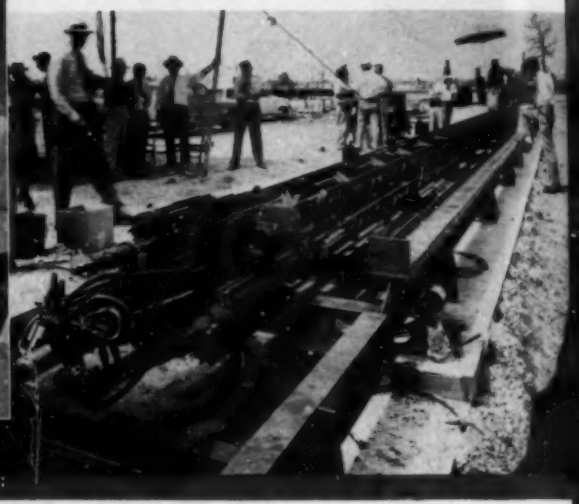
WELDON APPELT, President
R. E. TODD, Vice-Pres.
PAUL ROBISHAW, Engineer

A REVOLUTIONARY

FOR INTERNAL CLEANING . . .

LINE

The heart of the C-R-C internal cleaning and coating machine is this head which rotates at 250 rpm. The wire brushes clean the pipe and corrosion-resistant coating is sprayed from the guns at the left.



This over-all view shows the rotating head and the shaft which drives it through the pipe.

The rotating head enters the pipe after it has been clamped on the rack to begin the cleaning-coating operation.

This tractor drives the cleaning head through the pipe. Coating for the spray guns is in the tank in front of the operator.

Increased production through improved flow in your pipelines is now possible with the use of C-R-C's revolutionary new internal cleaning and painting machine. This new machine cleans the interior of the pipe and coats it in one automatic operation. Internal cleaning gives a smooth abrasion-resistant surface resulting in reduced turbulence and friction for substantially increased flow.

After the cleaning operation the machine coats the interior with a corrosion-resistant epon resin paint, developed in cooperation with Coast Paint & Lacquer Co., Inc. The unit is designed to provide pipe joints with this smooth interior surface and protective coating when they are received from the mill. Its use is also recommended on pipe that has been in storage for long periods to remove rust and corrosion before it is laid.

The new unit is an EXCLUSIVE* development of C-R-C. It is completely portable and can be used for stationary or on-the-job installations. The cleaned and coated, abrasion-resistant surface is desirable for use in gas pipelines as well as products and crude-oil lines. Consult C-R-C on this new pipeline development for improving production in your lines.

*Patent pending

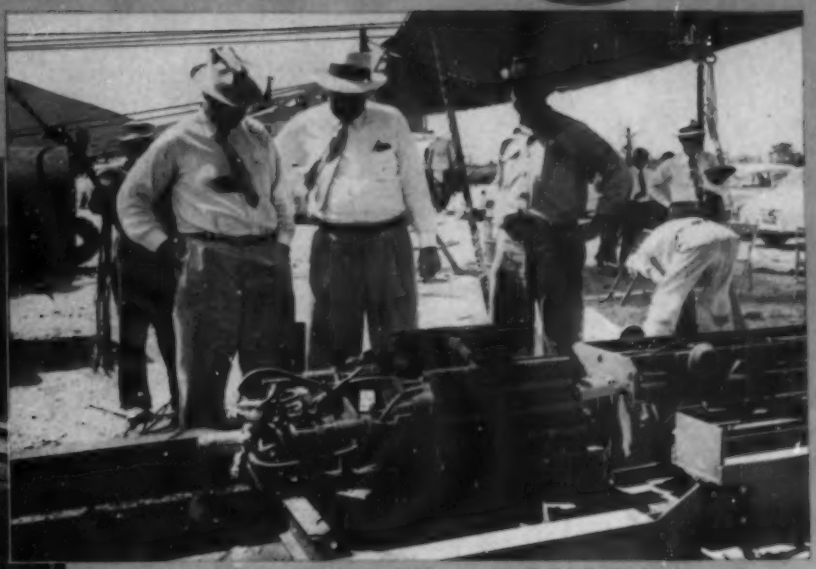
CRUTCHER • ROLFS • CUMMINGS, INC.

7825 KATY ROAD, HOUSTON, TEXAS • TULSA, OKLAHOMA

C-R-C has been First with every major development in pipeline equipment

DEVELOPMENT AND COATING OF PIPE

A supply of 5-gallon cans of special "Copon" formulated for C-R-C pipe application.



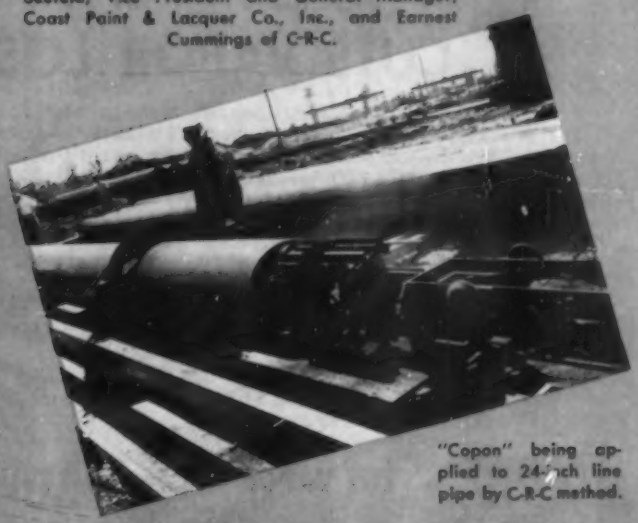
Left to right — Jim D. Cummings of C-R-C, Carl Seefeld, Vice President and General Manager, Coast Paint & Lacquer Co., Inc., and Earnest Cummings of C-R-C.

"COPON" . . . our epon resin coating is used by C-R-C for protection and preservation of line pipe.

Our chemists and engineers — working for weeks in close association with Mr. Jim Cummings — have developed and perfected the special "Copon" formula for the coating used in the revolutionary new C-R-C line pipe cleaning and coating process.

"Copon" adds years to the life and usefulness of line pipe.

- **It assures installation of rust-free pipe.**
- **It has exceptional tenacity, will adhere to metal surfaces longer and under more difficult conditions than any other coating yet tested.**
- **It is abrasion-resistant and has proven low erosion rate.**
- **It gives positive protection against rust and corrosion, also the chemical effects of crude oil, natural gas and salt water.**
- **It has amazing flexibility and elasticity.**
- **It provides a silky smooth, even surface that increases line flow by reducing friction.**



"Copon" being applied to 24-inch line pipe by C-R-C method.

Above the business end of C-R-C cleaner and "Copon" application.

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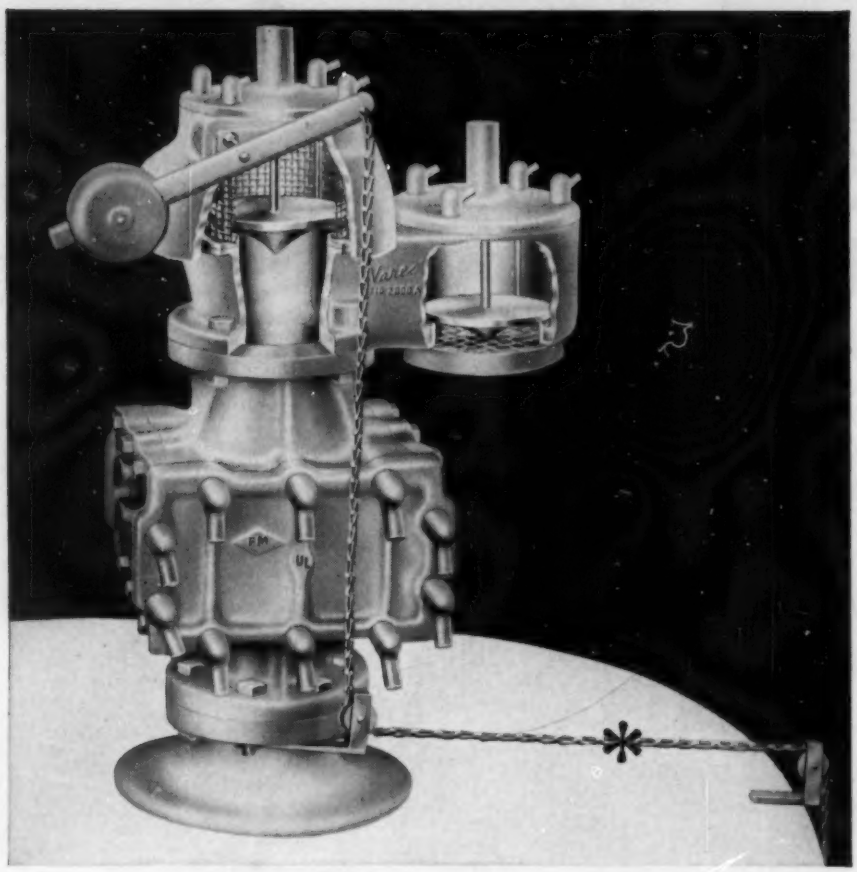

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* *Remote Control Flame Snuffer Sheave Brackets, Fig. 130 are optional at extra cost. This assembly is preferable where vent unit is set back from edge of tank.*

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constant study and revision to keep abreast of current best practices.

Flow Meter. Considerable interest has

About the Authors

ARTHUR H. NEWBERG, chief engineer for Service Pipe Line Company, received a B.S. degree in civil engineering from the University of Nebraska in 1940 and attended Washington University for graduate work. He is a registered professional engineer in Oklahoma, Wyoming and New Mexico and a member of ASME, NSPE, OSPE and API. Newberg joined Service in 1945 as senior office engineer and was appointed chief engineer in December, 1947. For 3½ years during World War II he worked in various capacities for the Office Engineering Division of the Panama Canal and the Williams Brothers Corporation on the design of pipe line facilities for the Armed Forces underground oil storage program.

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EDWIN C. SCHUSTER, engineer in the Research and Development Section at Service Pipe Line Company, received his B.S. degree in mechanical engineering from Marquette University in 1945. He joined the War Emergency Pipeline, Inc. immediately after graduation as an engineer under the pump station supervisor. In 1946 after operations of the Big and Little Inch pipe lines were suspended, he joined the faculty of Marquette University as an instructor in mechanical engineering. He became associated with Service in 1951. He is a registered professional engineer in Wisconsin.

been shown in a newly developed linear bidirectional flow meter that measures the true mass-rate of flow independent of the pressure, density, temperature, or viscosity of the flowing liquid. The meter measures the mass-rate of flow as a function of the moment required to apply a Coriolis acceleration to the fluid stream. Electronic weight measurement utilizing load cells may be another solution to the problem of accurately metering hydrocarbons.

Electrical averaging resistance thermometers have been developed to measure the average temperature of a volume of oil in a tank. Certain metals have the property of changing their electrical resistance uniformly with temperature; and, because of the stability of their temperature coefficient of resistance, they may be used to measure temperature. Since remote transmission of temperature readings is possible, automatic tank gauges augmented by electrical averaging resistance thermometers provide a simple, safe method of gauging tanks. A revised API Crude Oil Measurement Code now in preparation will endorse automatic gauges and temperature devices.

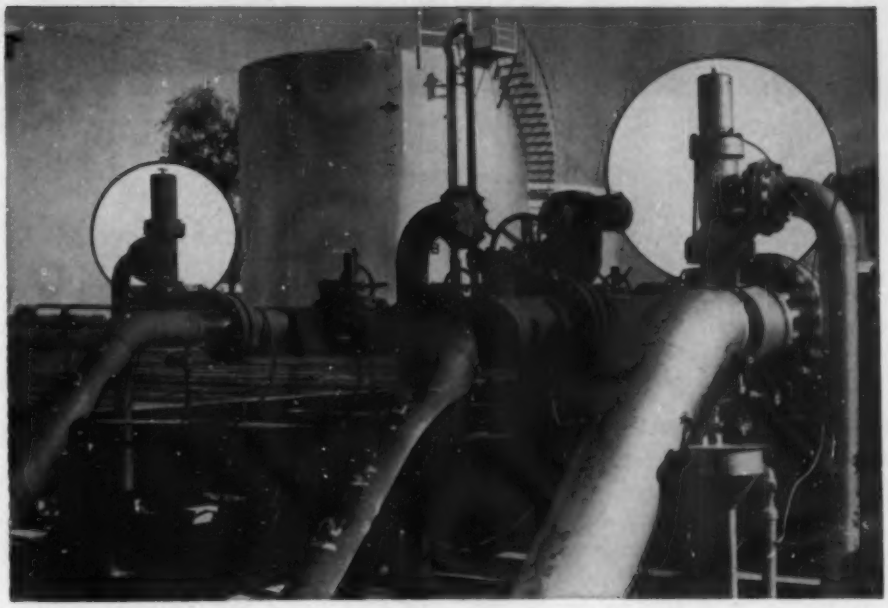
The Future. What can the pipe line industry expect in the future? Many of the technological advances mentioned have been tested and tried; others are still in the experimental stage and will require continued efforts to carry them to a satisfactory conclusion. Many current problems—such as elimination of pressure surges, brittle fracture of steel, and cavitation, to mention a few—still await a satisfactory solution. All of these have presented a formidable task to the pipe line industry.

But with the continual application of sound engineering and typical American ingenuity, these problems should present no greater hurdles than have been overcome in the past. It is difficult to visualize what the next new development will be, but if it results in better transportation of petroleum and its products, it will in all probability have its first application in the pipe line industry.

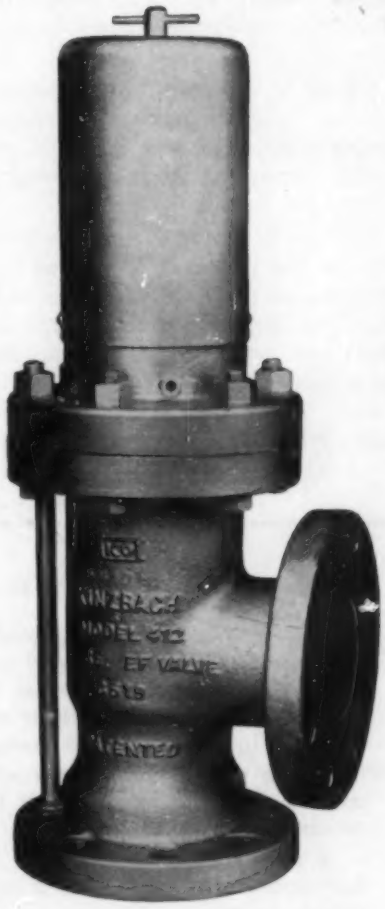
ACKNOWLEDGMENT

Excerpt from a paper entitled Modern Pipelining—Today and Tomorrow presented by the authors at the International Meeting of the American Society of Mechanical Engineers, Mexico City, March 12, 1954.

—The End



Positive Protection Against Pressure Surges



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Kinzbach Model 412 Relief Valves are available in 2", 3", 4", 6" and 8" sizes for working pressures up to 1000 p.s.i. Write for Bulletin RV412 for full technical data.

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Public Relations Is Everybody's Business

You'll find this both amusing and interesting. It will help you explain the gas business to your neighbor.

By MARSHALL WILLIS
Public Relations Director, El Paso Natural Gas Company

THE STORY goes that a trade association wrote to El Paso Natural Gas Company asking that the company be represented at a convention of the association. "Please understand," the letter is supposed to have concluded, "that those attending the meeting will be among the most successful and prominent executives in the nation. We do not want anyone lower than your publicity manager."

The company replied: "We shall be honored to be represented at your meeting. Please understand that at El Paso Natural Gas Company there *is* no one lower than the publicity manager." While, happily for this writer, the correspondence in question appears to be just one of the stories that floats around and never has actually been written, it is probably true that many think of a pipe line publicity man as a cross between a wart-on-a-pickle (useless but harmless) and mistletoe (a parasite, living on the work of others).

Generally speaking, a pipe line company (or the pipe line operation of an integrated company) involves no major sales problem. Natural gas is a premium fuel which could well command a price in excess of competing fuels but which almost universally sells for less. The merchandising of appliances is capably handled by natural gas distributors and by appliance dealers. At first glance, therefore, advertising and publicity (which are generally considered tools of sales) seem to have little importance to pipe line operations.

Messages to deliver. But there are many messages which a pipe line company needs to give to the public from time to time. Matters relative to rates, the expansion of service, and similar subjects merit the public's attention. In fact, it could probably be said that a pipe line company has an obligation to give information of some type to the public. The exact problems to be publicized, the technique of developing the message, and the media (radio? television? newspapers? magazines?) vary from company to company and from time to time.

There is, however, one message common to all companies which never lessens in importance: it is a hard, expensive, never-ending task to provide natural gas service.

And the best way to give this message to the public is for all of the employes of the company to be able to talk to their friends and neighbors about the work involved in moving gas to market.

Very few people outside the gas industry have any concept of what is involved in providing natural gas service.

People are willing to pay for and to support a service or product which they understand. In all of its problems—rates, regulations, financing, expansion of service—the industry will receive greater support from the public if the work which the industry does is known to the public and understood by the public.

To most people, any person working at a pipe line company is an expert on the gas business.

How it's done. It is not only advantageous to the company for employes to be able to supply information to the public but that the employe himself enjoys being well informed about the company. During the past eight years the company has added new employes at the rate of hundreds each year. In order to help these people become acquainted with the company and to understand the place they have in it, we have directed a rather intensive program toward employes explaining the company. Particularly fruitful have been a series of articles in the company magazine in which each of the various departments of the company were discussed.

In writing up the various depart-

MAP OF THE MONTH—El Paso Natural Gas Co. . . .

How big is El Paso Natural Gas Company today? No railroad line hauls as much weight to the West Coast as this gas company. The weight of the gas it ships daily is about 130,000,000 pounds. This is the weight of 16 loaded freight trains of 100 cars each, counting the weight of locomotive, cars and all.

- **The two-days' supply of gas in its lines exceeds a quarter of a billion pounds. And it travels at 30 to 40 miles per hour to customers.**
- **The company has 64 compressor stations with a total horsepower of 639,520. It costs $300,000 a year just to change piston rings.**
- **El Paso Natural has 8500 miles of horizontal pipe in its system; but to supply its gas, it takes 20,000 miles of vertical pipe in gas and oil wells.**
- **The company has about 4000 employes.**

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Hoover Dam
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Laguna Dam
Coolidge Dam
Roosevelt Dam
Theodore Roosevelt Dam
Painted Rock Dam
Gila Bend
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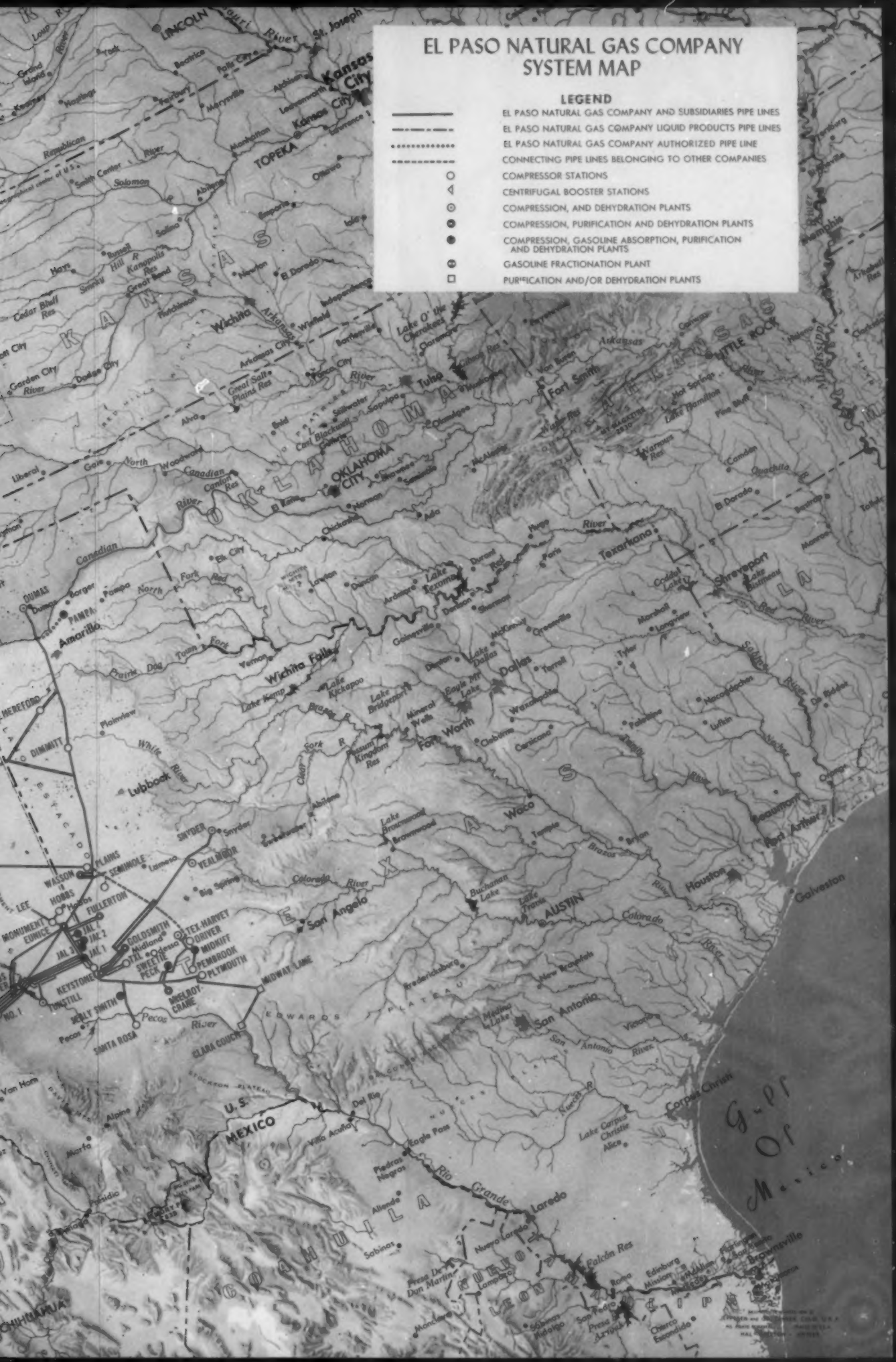
Capulin Mtn. Nat'l Mon.
Fort Union Nat'l Mon.
Kit Carson Nat'l Mon.
Sand Dunes
Red Desert
Continental Divide
Mountain Standard Time
Central Standard Time


EL PASO NATURAL GAS COMPANY
SYSTEM MAP
LEGEND
EL PASO NATURAL GAS COMPANY AND SUBSIDIARIES PIPE LINES
EL PASO NATURAL GAS COMPANY LIQUID PRODUCTS PIPE LINES
EL PASO NATURAL GAS COMPANY AUTHORIZED PIPE LINE
CONNECTING PIPE LINES BELONGING TO OTHER COMPANIES
COMPRESSOR STATIONS
CENTRIFUGAL BOOSTER STATIONS
COMPRESSION, AND DEHYDRATION PLANTS
COMPRESSION, PURIFICATION AND DEHYDRATION PLANTS
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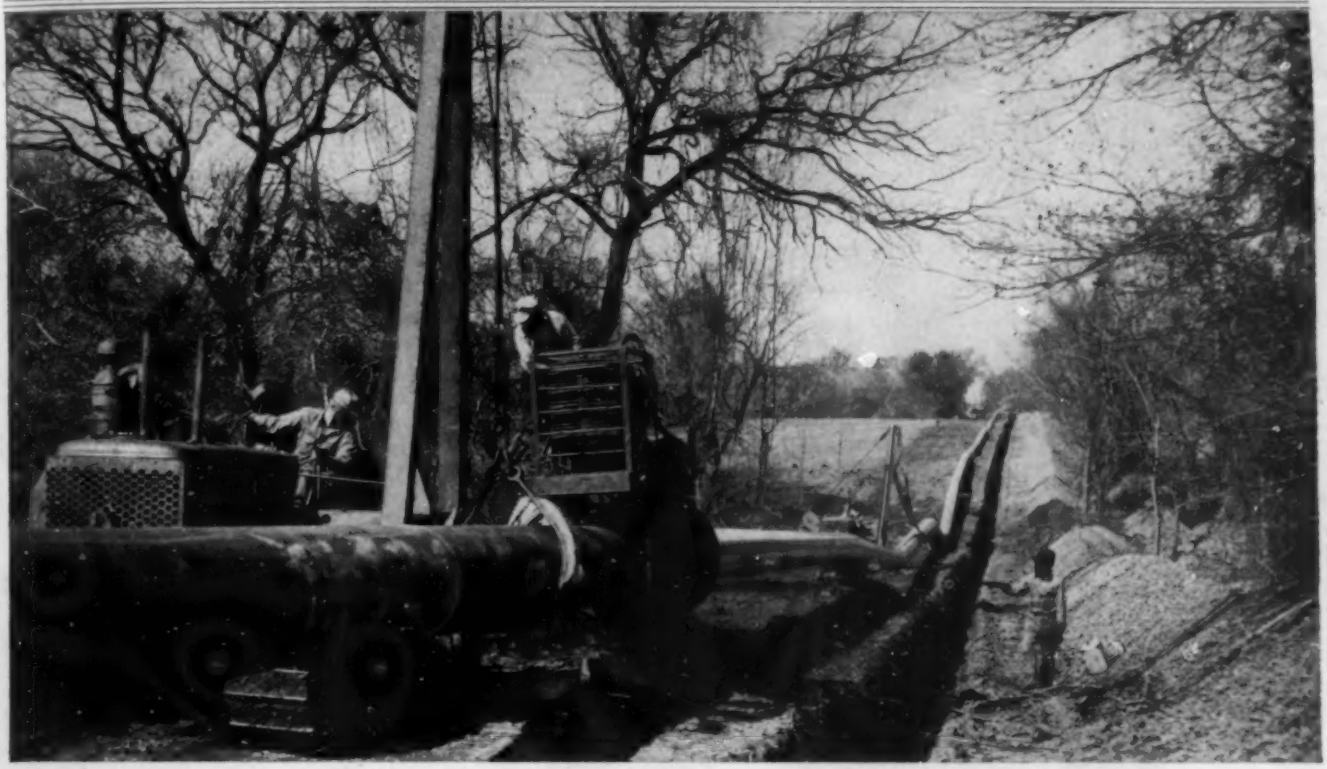
Sabine River
Rio Grande
San Antonio River
Nueces R
Lake Texoma
Lake Kickapoo
Lake Kemp
Lake Bridgeport
Eagle Mtn Lake
Lake Dallas
Lake Bob Sandlin
Lake Fork Reservoir
Lake Brownwood
Buchanan Lake
Lake Travis
Medina Lake
Lake Corpus Christi
Falcon Res
Amistad Res
Lake O' the Cherokees
Greers Ferry Lake
Lake Hamilton
Lake Ouachita
Millwood Res
Great Salt Plains Res
Cedar Bluff Res
Kanopolis Res
Glen Elder Res
Meredith Lake
Canadian Res
Lake Altus
Lake Meredith
Lake Arrowhead
Lake Kickapoo
Lake Murvaul
Toledo Bend Res
Caddo Lake
Lake Bistineau
Lake Claiborne
Lake Naconiche
Lake Sam Rayburn
Lake Livingston
Lake Conroe
Lake Houston
Lake Wallisville
Lake Anahuac
Lake Jackson
Lake Somerville
Lake Calaveras
Lake Medina
Lake Dunlap
Lake McQueeney
Lake Placid
Lake Amistad
Lake Casa Blanca
Lake Corpus Christie
Alice
Edinburg
Mission
McAllen
Brownsville
Harlingen
Port Isabel
South Padre Island
Laguna Madre
Gulf of Mexico
Presa Don Martin
Presa Las Adjuntas
Presa Falcon
Nuevo Laredo
Piedras Negras
Villa Acuña
Sabinas
Allende
Monclova
Saltillo
Hidalgo
San Pedro
Ojinaga
Presidio
Marfa
Alpine
Van Horn
Fort Stockton
Pecos
Santa Rosa
Clara Couch
Midway Line
Keystone
Tomtill
Kelly Smith
Shelby-Crane
Monument
Eunice
Jal 1
Jal 2
Jal 3
Goldsmith
Tex-Harvey
Orvier
Midkiff
Pembrook
Plymouth
Sweetie Peck
Wasson
Hobbs
Fullerton
Lee
Seminole
Plains
Snyder
Vealmoor
Dimmitt
Hereford
Stockton Plateau
Edwards Plateau
Chihuahua
Coahuila
Nuevo Leon
Tamaulipas

PIPE LINE PROGRESS



Dope gang preparing a string of A. O. Smith 26-inch welded steel line pipe for lowering in on the West Texas Gulf Pipe Line.

Biggest Inch to carry 381,000 bbl. per day from Permian Basin area

The West Texas Gulf Pipe Line, completed last February, is the largest single carrier of crude oil in this country. It has 465 miles of 26-inch pipe which extends from Colorado City in west Texas to Lucas, just outside Beaumont.

Present capacity of 301,000 barrels per day is being increased to 381,000 by the addition of intermediate pumping stations. Ultimately, capacity can be increased further to an estimated 440,000 barrels per day.

Crude oil from the Permian Basin area, containing more than 20% of the nation's oil reserves, is delivered to the Beaumont area and, through a 20-inch branch of 112 miles, to Longview, Texas, where it connects with other pipe lines serving Great Lakes and Ohio River valley refineries.

A considerable mileage of the 26-inch line is of A. O. Smith welded steel line pipe produced in Milwaukee and Houston. We are proud to have contributed to the construction of this, the Biggest Inch, as we have also to virtually every important petroleum products pipe line in the world.

A. O. Smith Line Pipe is available in a complete range of sizes and wall thicknesses, from 8⅝-in. to 36-in. diameters.

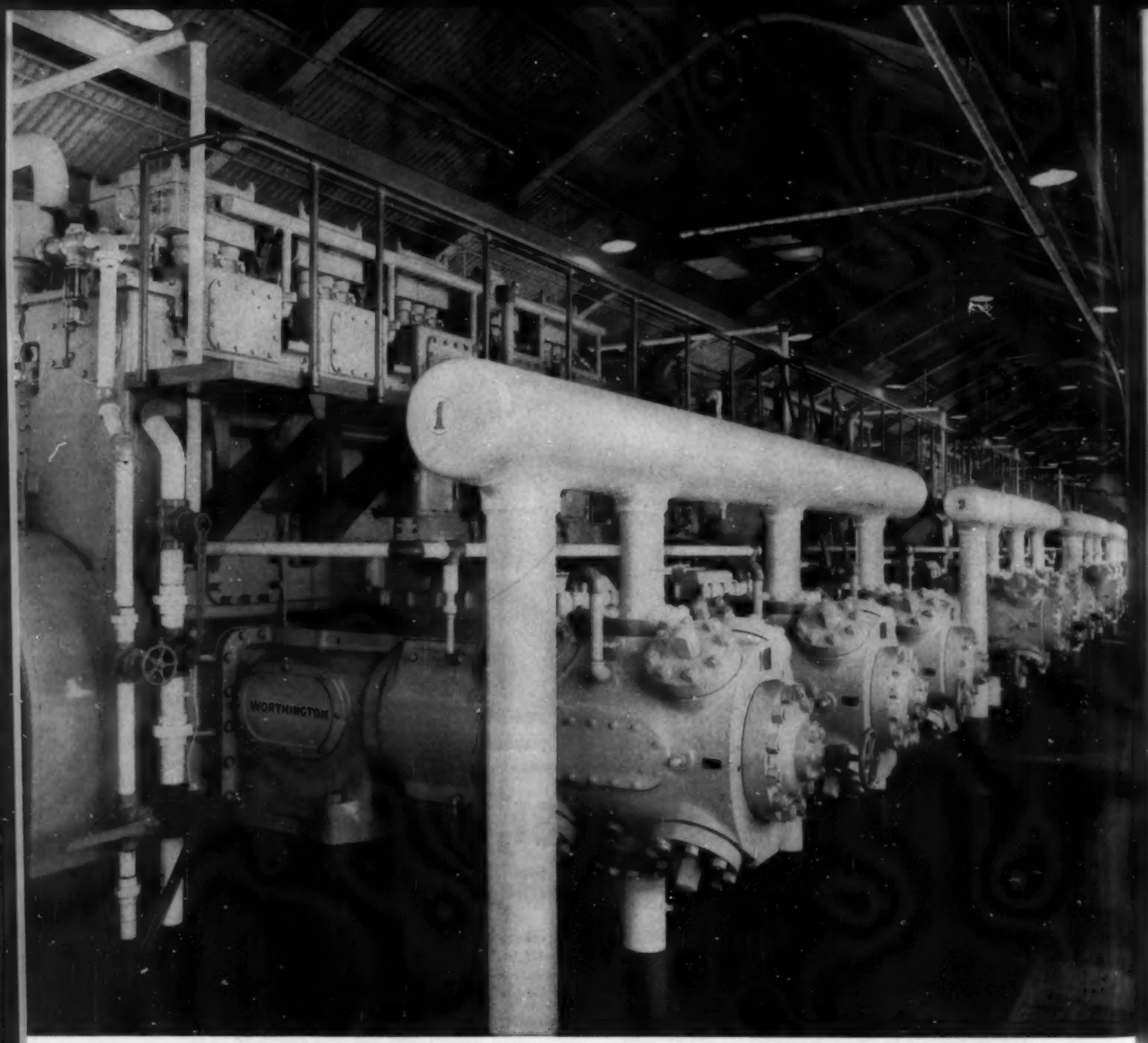
FIRSTS by A. O. Smith: Welded line pipe • Internally expanded pipe • Light-wall large-diameter pipe • World's largest producer of large-diameter welded steel pipe.

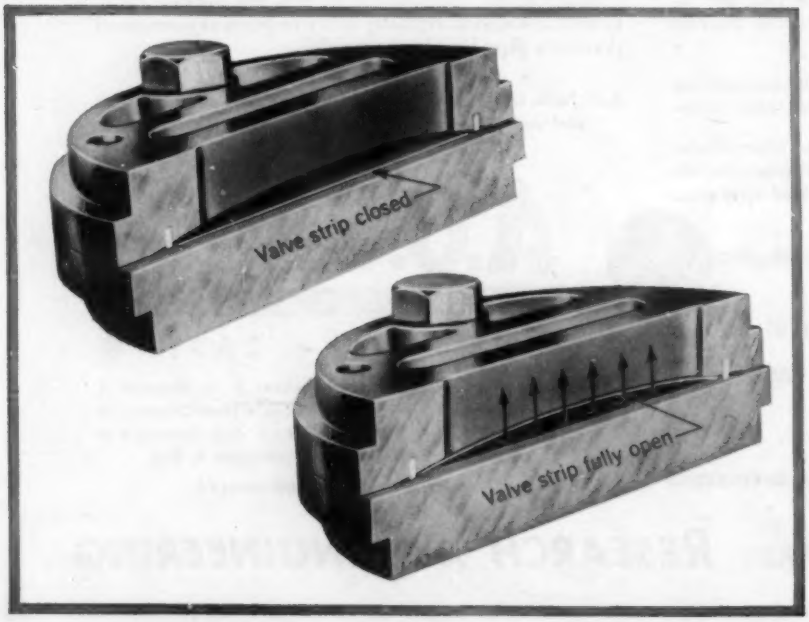
The A. O. Smith Casing Mill is operating at capacity to supply vitally needed casing for the Oil and Gas Industry.

A. O. Smith
CORPORATION
LINE PIPE • CASING

Chicago 4 • Dallas 2 • Denver 2 • Houston 2
Los Angeles 22 • Midland 5, Texas • New Orleans 12
New York 17 • Pittsburgh 19 • San Francisco 4
Seattle 1 • Tulsa 3 • Washington 6, D.C.
International Division: Milwaukee 1

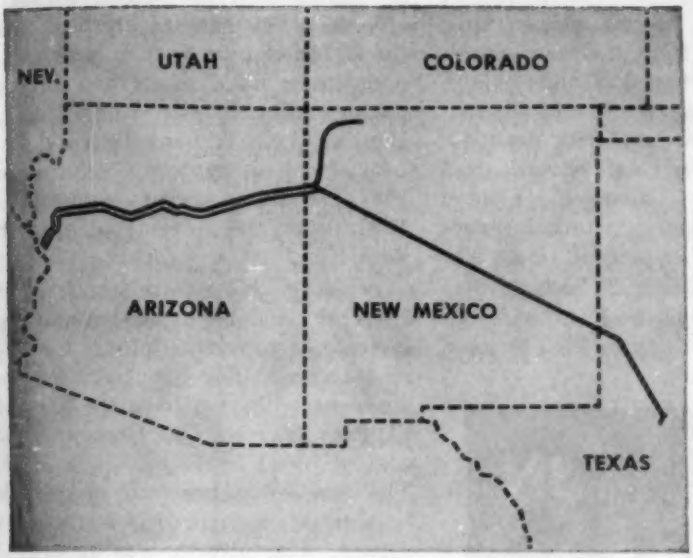
DEPENDABILITY THROUGH RESEARCH AND ENGINEERING



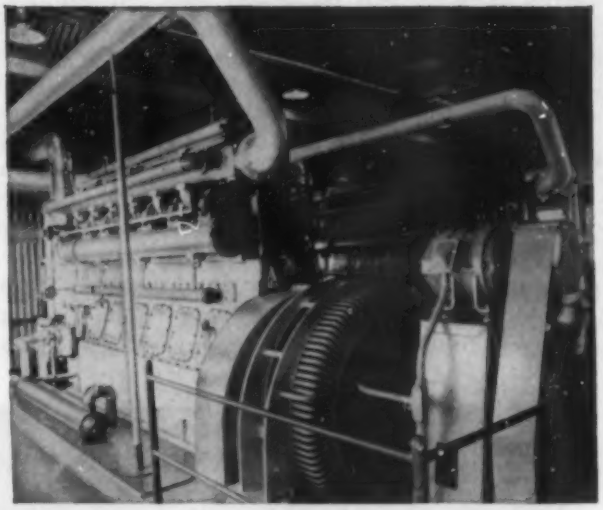


10,000 HORSEPOWER IS DELIVERED by these ten Worthington UTC Engine-Compressors in the Navajo Station on the El Paso Natural Gas line. Two 2000-hp Worthington UTC compressors are planned for the company's pending expansion at this station. They will handle a total of 687,000,000 cubic feet of gas when the installation is completed.

FEATHER* VALVE USED EXCLUSIVELY in Worthington compressors seats by contact, not by impact; ends remain in contact with the seat at all times. It operates quietly, efficiently, and with minimum maintenance.



PROPOSED 792 MILE, 30" PIPELINE to add 400 million foot capacity will run from the Permian Basin in Texas to Franconia, Arizona. The Navajo Station, largest in the line, will use a total of thirteen Worthington UTC Engine-Compressors.



ELECTRIC POWER for the Navajo compressor station is supplied by these two Worthington type CCG-6 gas engines which drive Electric Machinery generators. Such an economical means of generating power should not be overlooked when compressor stations are planned. Another CCG-6 is planned to supply additional power at the Navajo Station.

13 Worthington UTC Engine-Compressors planned for new El Paso Natural Gas line

The El Paso Natural Gas Company plans to install 13 Worthington Uniflo two-cycle engine-compressors on its new 792-mile line if the project is approved by the Federal Power Commission. These are in addition to the 18 units that the company already has in operation or in process of installation on this line.

The new 30-inch main transmission line will originate in the Permian Basin and extend in a northwesterly direction across New Mexico to a point near Gallup. There junction will be made with the existing 24-inch main transmission pipe line from the San Juan Basin. From that point west, the new 30-inch line will loop the present San Juan line to a point close to Franconia, Arizona, near the California border. This line will make possible additional deliveries totaling 400 million cubic feet of gas per day; 300 million cubic feet per day coming from the Permian Basin and 100 million cubic feet per day from the San Juan Basin.

The Navajo and Leupp compressor stations, first and second to handle the full 687 million cubic feet per day (the San Juan system is currently authorized for 287 million cubic feet per day) are both fully equipped with Worthington UTC Engine-Compressors exclusively.

Standard equipment on Worthington UTC's is the exclusive Feather* Valve—a factor that contributes materially to long life and trouble-free performance. The Feather Valve has long been recognized as the lightest, tightest, most durable and efficient valve obtainable.

While Worthington UTC compressors are widely used for pipeline gas compression, they are also well suited to many other jobs, such as pressure maintenance on oil wells; varied service in natural gasoline plants; solvent extraction, vapor recovery, and recycling and stabilization of gases in oil refineries.

If your business requires gas compression, it will pay you to write for further information on the Worthington UTC Engine-Compressor. Sizes range from 1,000 to 2,000 hp. Write to your nearest Worthington district office for Bulletin S-500-B23B. Or write directly to Worthington Corporation, Engine Division, Buffalo, New York. EK.3.2

*Reg. U. S. Pat. Off.

WORTHINGTON

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON

ments, we have found that the average employe has trouble describing his work to an outsider for one or both of two reasons. First, he may not realize the great interest his work will have for others and pass off an inquiry with a vague "Oh, I don't do much of anything. Just tend to the machinery here" or, second, he will use such technical terms that the layman cannot understand them. We have tried, therefore, to help each employe grasp the significance of his job (or, at least, of his department's job) and to supply him with graphic means to talk about his job.

Take the matter of the company's growth, for example. The number of miles of pipe line in service have grown from 2165 at December 31, 1945 to more than 8500 today (both data include both field and gathering lines as well as mainlines). In 1945, El Paso Natural Gas Company had ten compressor stations; today there are 64. Compressor station horsepower is up 1250 percent (from 50,900 in 1945 to 639,520 today). System capacity has been raised from 152,410 mcf per day in 1945 to more than 2 million mcf per day at present.

It has been found that people could not understand the reason for this growth. They readily grasped that the laying of pipe lines to new areas necessitates more assets and higher volumes of deliveries. But El Paso Natural Gas Company began deliveries of gas to southern California in 1947 and to northern California in 1950. Why the tremendous growth since then?

Primarily this growth has resulted from the economic expansion and the increase in population of the area already served. The population of the areas served by gas from the lines of El Paso Natural Gas Company increased by at least 485,000 in 1953. The same or higher rates of growth have been experienced over the past decade. The growth was described this way: "Every year the population growth in the area we serve is as great as the population of Cincinnati, greater than that of Dallas, Indianapolis, Kansas City, or San Diego. Each year we add a major city."

Continuous job. Once the significant growth of the area served by El Paso Natural Gas Company is grasped, the person immediately understands that the company has almost constantly been putting down new pipe lines, putting up new plants, and acquiring greater reserves.

One of the major problems in the growth of the company (as is true in the case of all pipe line companies which have grown this rapidly) has been the need to develop new gas reserves. Very few people realize that new wells have to be tied-in to the system constantly, both to meet the needs of increased population and to maintain service to those already receiving natural gas. El Paso Natural Gas Company currently has more than 18,000 wells tied-in to its system (most of these wells belong to independent producers, of course). Drillers and people familiar with the oil and gas industry appreciate the significance of this datum; the general public does not. This statement helps point up the importance of the wells, however: "El Paso Natural Gas Company has about 8500 miles of pipe line extending horizontally across the face of the earth to carry natural gas from wells to market. But there are more than 20,000 miles of pipe going

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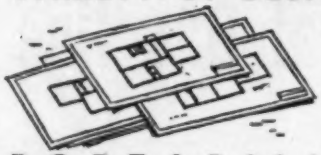
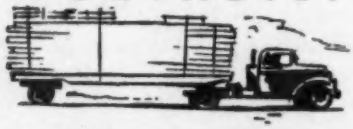
PREFABRICATED HOUSES

VARIETY OF DESIGNS . . .



Choose from a large selection of homes, garages, warehouses and other buildings. Get what you want in STURDYBILT.

PORTABILITY . . .



Complete housing sections moved anywhere a truck can go. Buildings erected on your site in days instead of weeks.

DEMOUNTABILITY . . .

Move your STURDYBILT houses when you abandon an old site. They can be erected on new location with practically no loss of material.

ONE SOURCE . . .

One purchase order takes care of designing, transporting and erecting. Truly one stop buying when you get STURDYBILT Prefabricated Houses.

MANUFACTURERS OF SPECIAL MILLWORK: DISTRIBUTORS OF JOHNS-MANVILLE BUILDING MATERIALS; CURTIS WOODWORK

STURDYBILT PREFABRICATED, DEMOUNTABLE HOUSES

SOUTHERN MILL & MANUFACTURING CO. • TULSA, OKLAHOMA

STURDYBILT HOUSES COMPLY WITH COMMERCIAL STANDARD CS 120 OF THE NATIONAL BUREAU OF STANDARDS FOR PREFABRICATED HOMES

straight up and down just to bring that gas to the service."

El Paso Natural Gas Company has authorized main line capacity of 1,988,000 mcf of gas per day. In addition, the company moves up to 320 mmcf cubic feet of gas per day under the "exchange" agreements reached with Northern Natural Gas Company and its subsidiary, Permian Basin Pipe Line Company, and has sales at the field (not considered a part of the mainline authorized capacity) of up to several hundred million cubic feet of gas per day. An affiliated company, Utah Natural Gas Company, delivers about 50 mmcf cubic feet of gas per day. Thus it is conservative to say that the company delivers 2 billion cubic feet of natural gas per day.

The aim was to show the size of this job and to put it into terms the public could understand. Generally speaking, the biggest moving thing with which people are familiar is a locomotive—a train. Our dispatchers checked on the weight of 2 billion cubic feet of gas. The answer: 130,000,000 pounds, equivalent to 16 100-car freight trains fully loaded including the weight of the locomotive, cars, and all. (As nearly as could be determined, the greatest tonnage of freight moved west by any carrier—railroad, airline, or truck line—is the gas carried west by El Paso Natural Gas Company.)

Because the gas moves at an average rate of about 30 to 40 miles per hour, there is roughly a two day supply of gas in the pipe lines at all times. A quarter of a billion pounds of natural gas, rushing to consumers. The layman readily grasps the significance of this datum. This helps him to understand the need for compressor power and valves and all the other things to keep the gas moving in the right direction.

When it is explained that the company has nearly 640,000 horsepower in compressor facilities (the exact figure is 639,520), the layman understands that these stations to a pipe line company are what locomotives are to a railroad. But horsepower is of particular significance only to engineers and technical men. The public grasped this fact quite readily: counting labor, it costs the company more than $300,000 per year just to change its piston rings.

One of the most unusual features of El Paso Natural Gas Company's operations is that the greatest part of the gas carried to market is residue gas, a byproduct of the production of oil. (To the public it is explained: residue gas bubbles out of oil when that oil comes out of the ground just as carbon dioxide bubbles out of soda pop when a bottle of that beverage is opened.)

Most of the information which we developed is passed on to the public by employes in private conversations. Figure it out. Almost every day, an employe is queried by a friend or neighbor. Almost certainly our 4000 employes talk once each week to some person outside the company. And, by reaching these 4000 members of the public each week, we are able to reach 200,000 or more in a year. It takes a lot of expensive advertising to reach that many people as effectively as they are reached in private conversation.

Public relations is everybody's business. We feel that our job to a large extent is to help each employe arrive at terms and descriptions which will help him describe the company to his friends. —**The End**

A GOOD START.. for a Long Life!

● This RUBEROID pipe line asbestos felt over PITT-CHEM hot applied tar base coating will withstand the severe corrosion attacks this pipe line may meet. The quality control to rigid specifications of these products assures years of protection for this line against moisture and electrical forces, as well as soil stress and root attack. And when you start a job, a Day man is there to give the benefit of his experience for a good start . . . part of the *plus* in the service you get when you "DEAL WITH DAY."

Both of these products are stocked in Houston for immediate delivery when you're in a hurry.

Engineering counsel, literature including specifications, and prices are furnished through our Houston office.

S. D. Day Company is National Distributor for The Ruberoid Co. pipe line asbestos felt, and Gulf Coast Distributor for Pittsburgh Coke & Chemical Co. hot and cold applied coal tar coatings, and American Coating & Supply Company "Fieldjointers."

The Pipeliner's Friend says,

"Get Formula 291 — it gives skin protection for those working where fumes may be toxic."

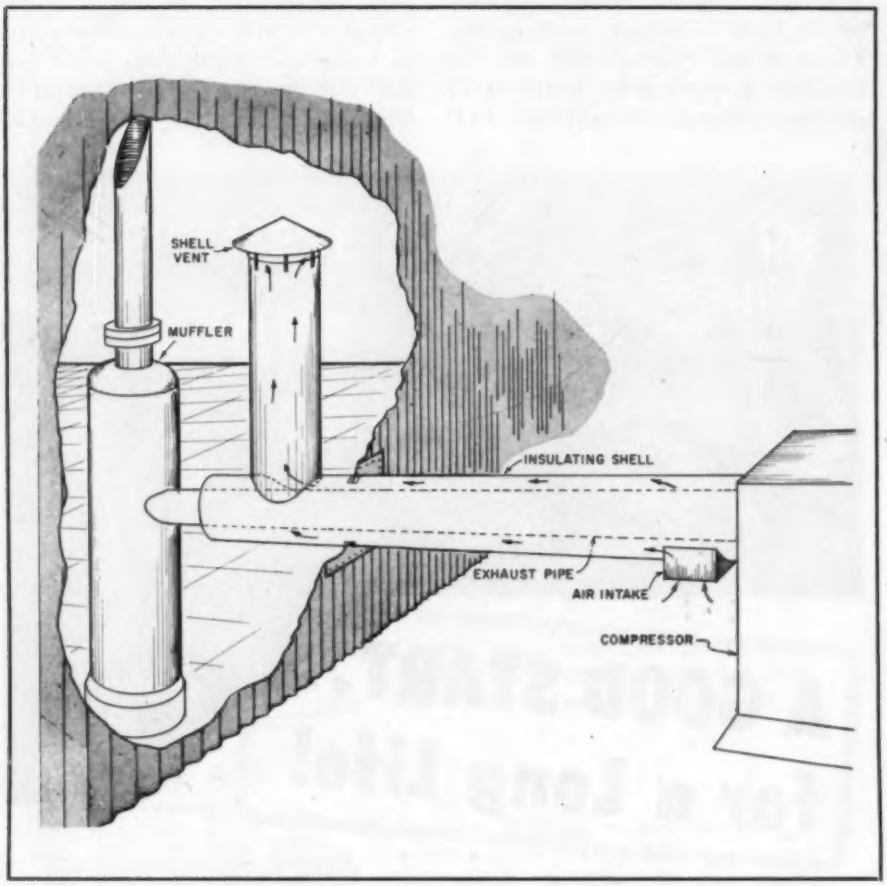
S. D. DAY COMPANY

1973 WEST GRAY HOUSTON, TEXAS PHONE JU-2431

How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, Box 2608, Houston 1, Texas.



Insulate Exhaust Piping With Metal Cover

Exhaust piping may be insulated at low cost by means of a galvanized sheet metal cover spaced evenly around the piping and vented outside the building to achieve a chimney-like draft in the annular space.

High temperatures of exhaust gases —500°-900° F. is usual range—cause exhaust piping to give off undesirable heat inside the compressor building, and in some cases, present a hazard to operating personnel. The sheet metal insulating shell, or case, around the exhaust pipe should be made in two parts, flanged so they can be bolted together around the pipe with stove bolts. Radius of the shell or case should be about 4 inches greater than that of the pipe. Air inlet must be provided by a square opening inside the compressor building near the engine. Air is vented outside the building by a stack or chimney with a rain cover. The stack is braced to the tail pipe on the silencer.

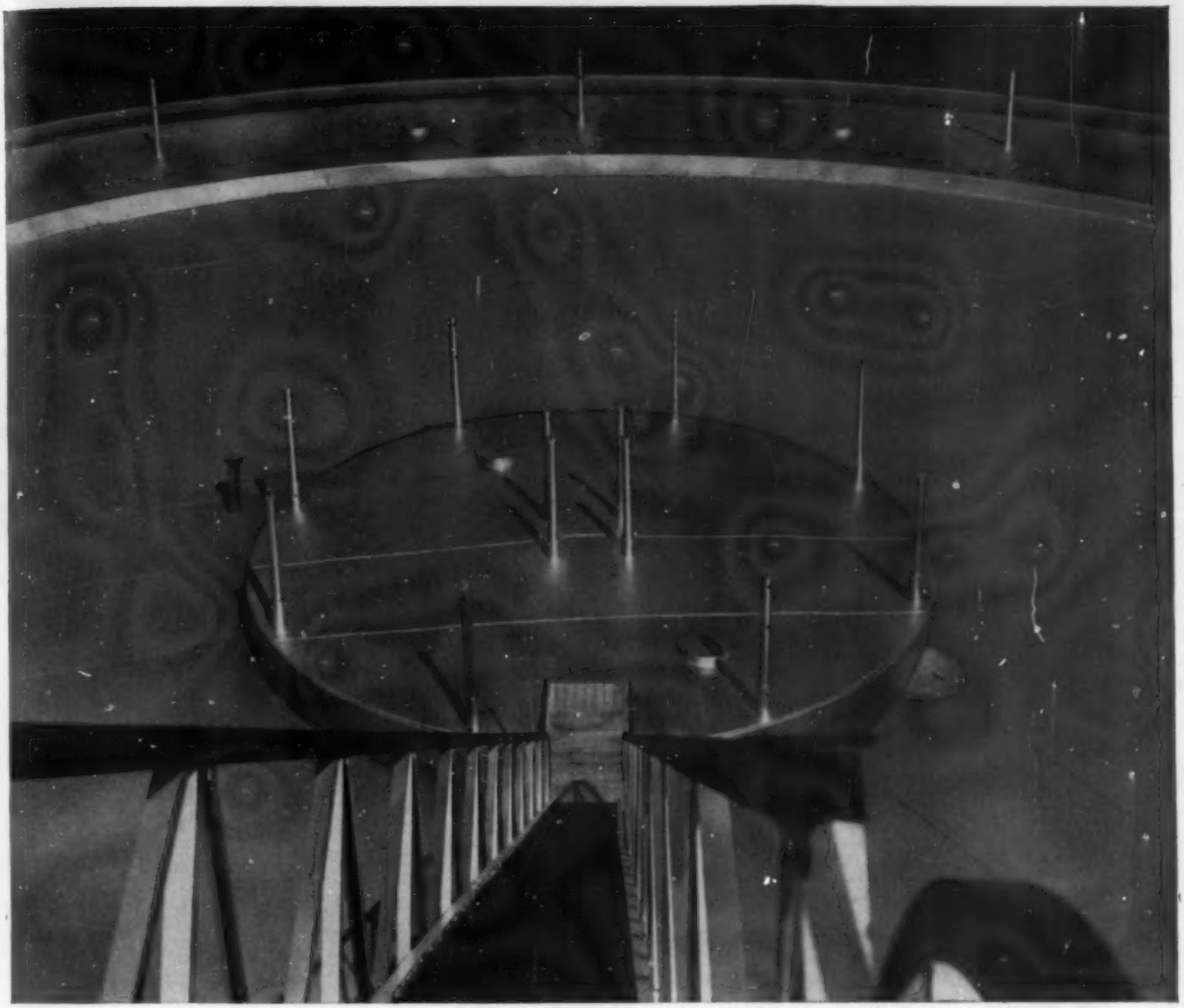
To make the horizontal section of the galvanized covering fit snugly around the exhaust pipe, each end is crimped and soldered. Air leakage is not critical, so no great effort must be made to get the joint air-tight. Brackets around the exhaust piping centralize the shell and pipe, making the annular space uniform.

An extra advantage of this type of installation is that air and gases from the compressor building are vented to the atmosphere.

Unitized Drip Device Is Made of Scrap Material

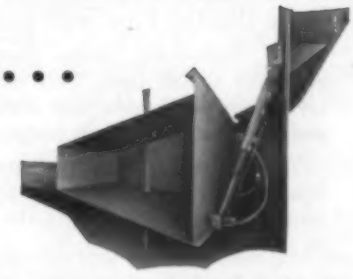
A unitized drip to catch all entrained liquids has been developed by a Gulf Coast company. It consists of swelling out the main line to slow down the flow of gas, then hanging a pot of a line of smaller size on the bottom of the line with a large connection so that all the liquids will be caught as they go by. This device is placed in the lowest part of the line and is attached by means of the drip line and a plate welded to the other end for bracing. One outlet is provided so that the condensate may be blown to a drip tank and saved.

By making the main line larger at the point of the drip, it provides space for the liquids to fall out and be caught in the container hung on the bottom of the line. By making the drip a part of the line, swing-joints are eliminated and the drip itself moves with the line under expansion and contraction. The blow-off line, being of small diameter and swung at right angles to the main line, will not be in danger of breaking out during movement of the line under expansion and contraction. This entire unit may be buried on the main lines and the connections to the main line are strong enough that the drip will make its own space in the ground and allow for expansion and contraction.



You are looking down...

into a Graver Center-Weighted "Floater." It's a well-built tank especially designed to conserve volatile vapors by means of Graver's own "Vapor-Stop" Seal—the improved seal which maintains firm closure between the floating roof and the shell. This patented Graver seal mechanism is an integral part of all Graver Floating Roof designs. It is flexible, yet firm—tight, yet responsive. It provides centering action for the roof and prevents the entrance of air and rain. From time to time you may expect similar technological improvements from Graver...where increasing emphasis will continue to be placed on research and development.



Graver's "Vapor-Stop" Seal!

The seal is free and limber, yet continues to close the gap and prevent loss of vapors. It is successful on both converted tank shells and new construction.

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...a conservation design to fit every need

GRAVER TANK & MFG. CO., INC.

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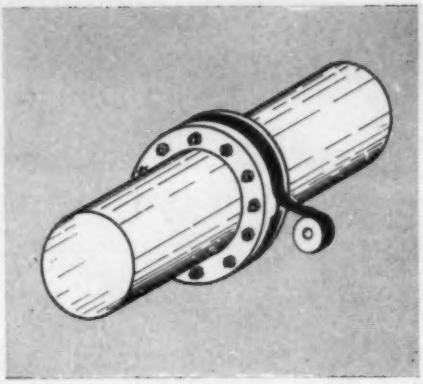
Plastic Tape Seals Gap Between Flanges



Using plastic tape to seal off the gap between mated flanges can minimize corrosion by protecting exposed studs and flange faces from moisture, salt air, industrial gases and dirt.

At a gas pipe line terminal a few miles from a salt water bay, corrosion was taking a heavy toll in studs and flanges. Salt air and corrosive industrial gases attacked the insulated studs and flange faces in the space between mated flanges. The narrowness of the gap between flanges made measures to seal off the highly stressed steel studs ineffective.

Engineers at the terminal came up with a highly satisfactory solution to the problem. They applied polyethylene plastic tape, which has high electrical resistance and excellent sealing properties, to the gap between mated flanges. The tape was applied after the studs and flange faces were coated with corrosion inhibitor. A band of tape was wound around the pairs of flanges, overlapped to seal off the interior. The tape adheres to the metal surfaces of the flanges, so that air and the impurities it carries cannot enter the space between the flanges.

This method of control proved so successful that it is now being used on plug valves, meter runs and other flanged installations at the terminal.

STOP CORROSION AND PARAFFIN PROBLEMS WITH TUBE-KOTE PLASTIC PIPE

Here's how to eliminate corrosion and paraffin problems on gathering lines — install Tube-Kote Plastic Pipe! No need to wrap or tape because Tube-Kote Plastic Pipe will never rot, rust or corrode!

Use Tube-Kote Plastic Pipe and you will eliminate all corrosion problems at one time. You will also eliminate paraffin deposition and save shut-down time and maintenance costs. You will have a better pipe that will last years longer.

You can transport Tube-Kote Plastic Pipe for less cost, and install it in less time, because it is only 1/6 the weight of steel pipe!

Made by Tube-Kote, Inc. — world's largest processors of plastic coatings and linings for steel pipe—pioneers in plastics since 1939!

- Used throughout the industry for gathering lines, disposal lines, gas service lines, water lines, etc.
- Only 1/6 the weight of steel pipe—easier, faster to install.
- Smooth interior surface reduces friction loss—slashes pumping costs!
- No wrapping or taping needed—Tube-Kote Plastic Pipe is self-protective.

Write today for information and prices.

TUBE-KOTE, INC.
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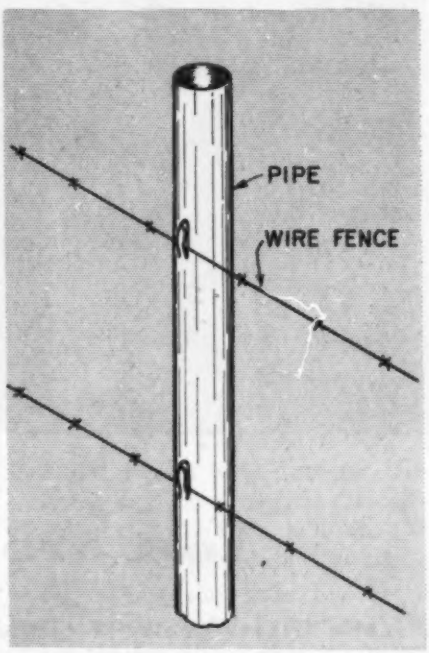
TUBE-KOTE
First Name In Corrosion Resistance

TUBE-KOTE T.M. Reg.

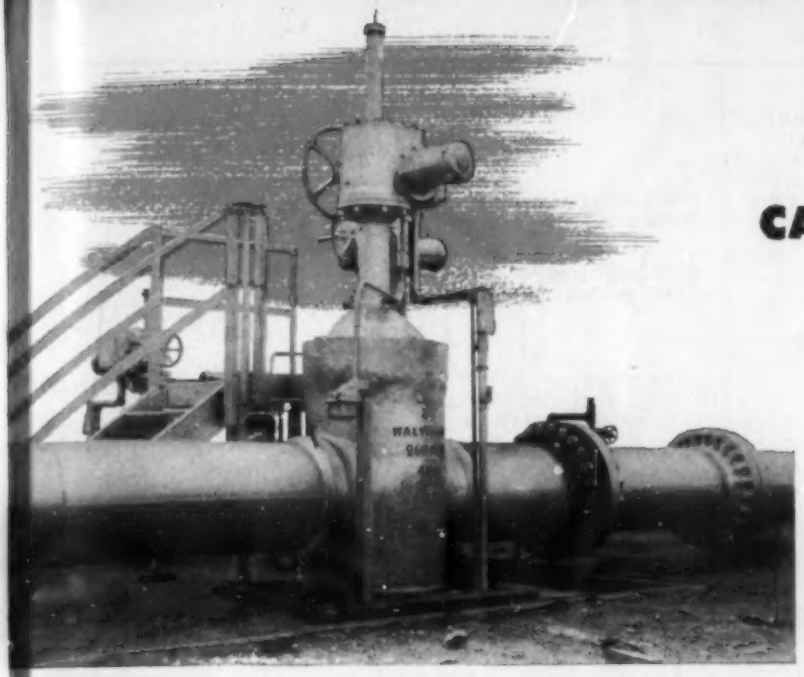


Scrap Pipe Can Be Used For Lasting Fence Posts

An excellent fence post for barbed wire around plant sites can be made from scrap pipe.

The pipe should be burned on one side to form lugs at desired elevations as shown. Inverted V's are burned in the pipe, and the tooth-like lugs are wedged outward to hook the wire. The wedges should be bent tightly into the pipe at the time wire is strung to clamp it into place.

Set in concrete, the pipe makes a long-lasting fence post.

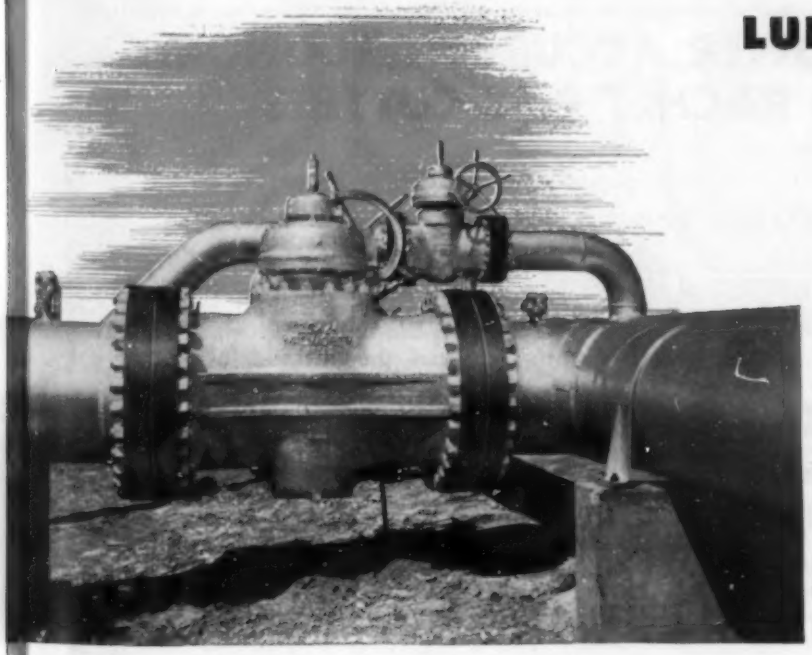


CAST STEEL GATE VALVES

A 24-inch Walworth Type 49 Series 400, 960 WOG, Cast Steel Gate Valve with welding ends and motor operating device, on a pipeline handling crude petroleum.

Walworth Type 49 Valves are especially designed for service on pipelines handling gas, refined products, or crude oil. Through-port construction allows free passage of pigs and scrapers. These valves do not require any internal lubrication and may be installed without regard to direction of flow.

WALWORTH makes both for pipeline service



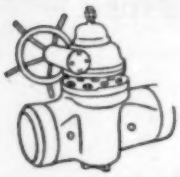
LUBRICATED PLUG VALVES

A Walworth 26 x 24-inch, 1000 WOG Cast Steel, Worm Gear Operated, Flanged, Lubricated Plug Valve installed on main line discharge of a gas pipeline.

Walworth Lubricated Plug Valves afford quick, easy operation . . . a quarter turn gives full, direct port opening. The lapped surfaces of the plug and body, plus the seal afforded by the lubricant, assure a tight, leakproof valve.

Always use Walworth lubricants in Walworth Lubricated Plug Valves.

Let us help you with your pipeline valve problems. Because we make *both* gate valves *and* lubricated plug valves, we can give you an unbiased recommendation regarding the best type of pipeline valve for your particular need. See your nearest Walworth distributor, local Walworth representative or write: ***Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.***



Walworth Lubricated Plug Valves for Pipeline Service

Made of cast steel. Sizes up to 30 inches. Working pressures up to 5000 psi.

Walworth Type 49 Cast Steel Pipeline Gate Valves

Sizes 2 to 30 inches, inclusive. Series 400 and 600 for working pressures up to 1440 psi.

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Manufacturers since 1842

valves . . . fittings . . . pipe wrenches

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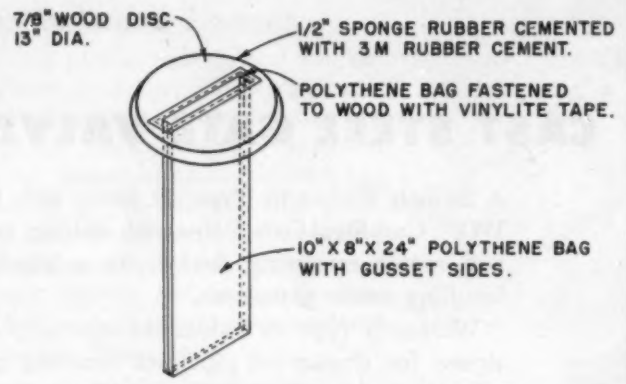
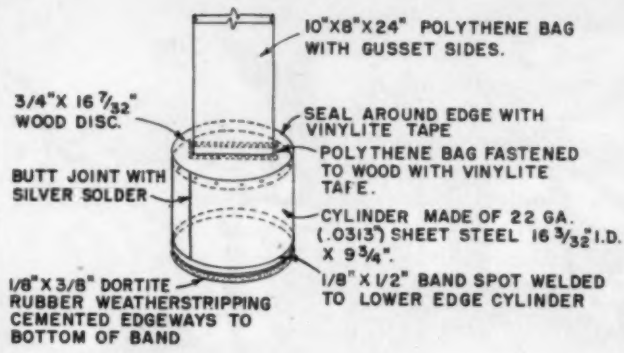

7/8" WOOD DISC. 13" DIA.
1/2" SPONGE RUBBER CEMENTED WITH 3M RUBBER CEMENT.
POLYTHENE BAG FASTENED TO WOOD WITH VINYLITE TAPE.
10" X 8" X 24" POLYTHENE BAG WITH GUSSET SIDES.

VACUUM PALLET TESTER


10"X8"X24" POLYTHENE BAG WITH GUSSET SIDES.
3/4"X 16 7/32" WOOD DISC.
SEAL AROUND EDGE WITH VINYLITE TAPE
POLYTHENE BAG FASTENED TO WOOD WITH VINYLITE TAPE.
BUTT JOINT WITH SILVER SOLDER
CYLINDER MADE OF 22 GA. (.0313") SHEET STEEL 16 3/32" I.D. X 9 3/4".
1/8" X 1/2" BAND SPOT WELDED TO LOWER EDGE CYLINDER
1/8" X 3/8" DORTITE RUBBER WEATHERSTRIPPING CEMENTED EDGEWAYS TO BOTTOM OF BAND

PRESSURE PALLET TESTER

Plastic Bag Is Used to Check Valve Leakage

A plastic bag can be used easily by non-technical personnel to check leakage rates on vacuum and pressure-vent valves.

The loss from leakage and the greater danger of roof blowouts from excessive pressure are problems which require constant attention. To do a good job, vent valves should open wide for the shortest possible period when conditions demand, and should seal perfectly tight when closed.

As the vent openings of conservation valves are frequently somewhat irregular, it is not feasible to determine the leakage rate with a standard anemometer. The polythene bag can easily be clamped in place, and its filling rate can be checked against time.

This idea is taken from a paper presented to the Fifth Annual Spring Products Pipe Line Conference and Field Trip, under the auspices of the American Petroleum Institute's Division of Transportation.

FOR SPEED, SAFETY, POWER, ACCURACY, ECONOMY . . . IT'S ALSTON RACHET PIPE CUTTERS

On pipe lines, on rigs, in refineries . . . it's tops in dependable service.

FEATURES: Eliminates dangerous sparks and broken cutters—rollers hold pipe taut after cutting. Cutters go on and off pipe quickly . . . only one pin operation.

Patented roller guides assure correct cut. It's sturdy, and rachet principle permits close work. Proved in use by major companies. Sizes for every need in cutting steel or cast iron pipe.

Write for literature, prices, and detailed information.

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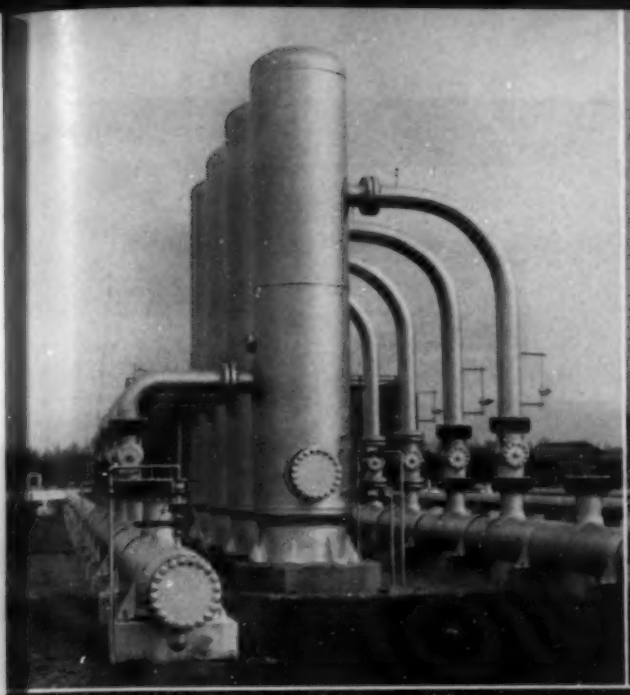
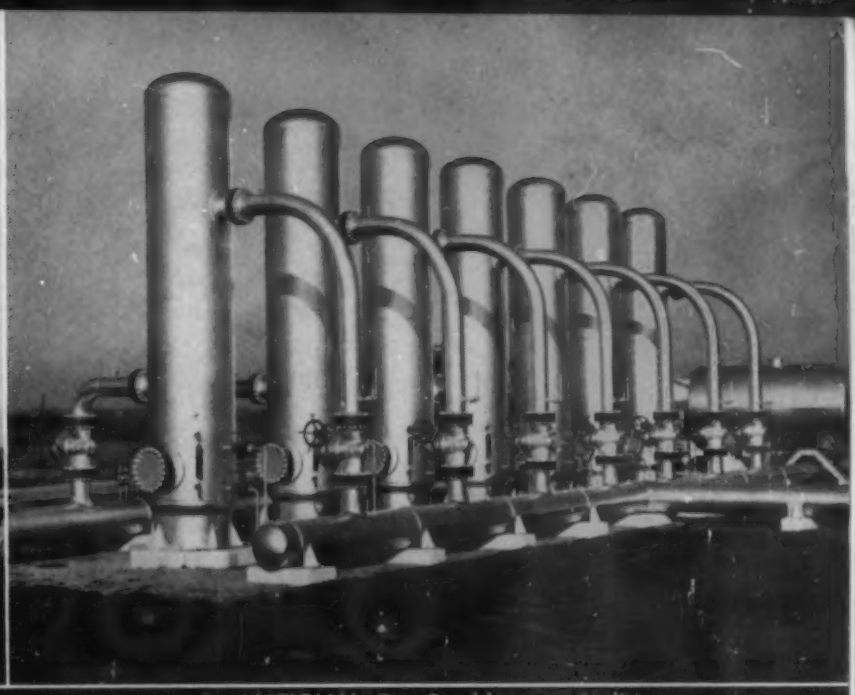
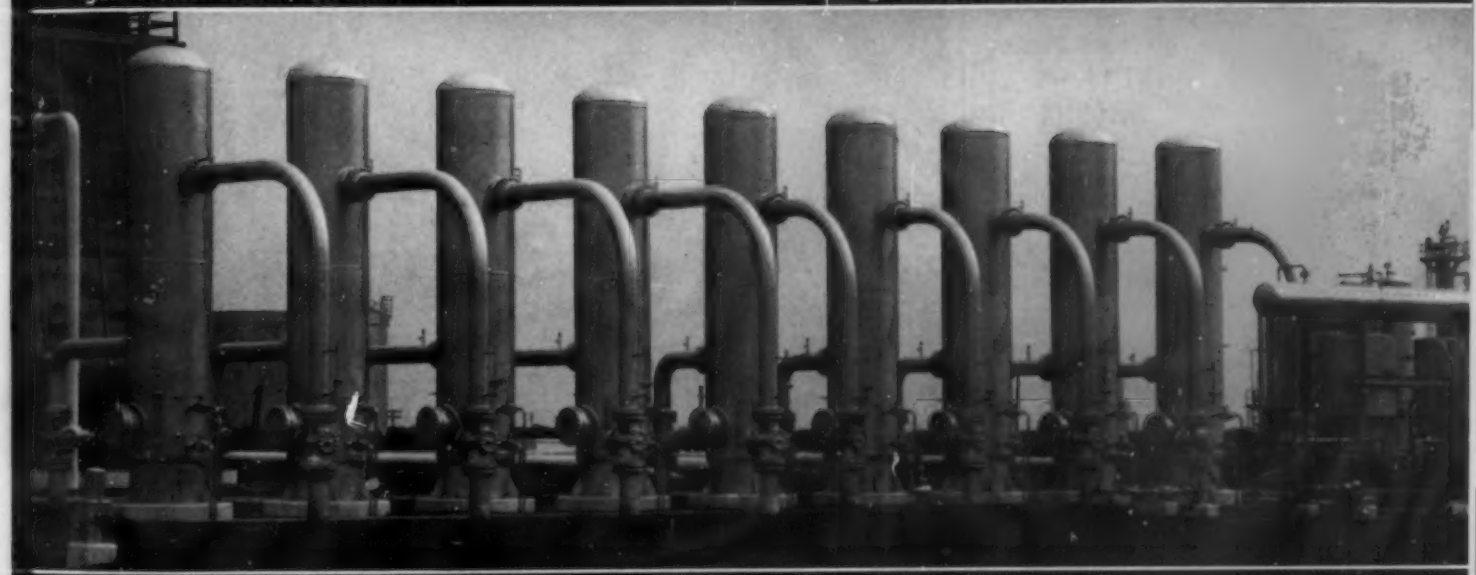


NATIONAL Gas Scrubbers, main line gas booster station, Batesville Miss.



NATIONAL Gas Scrubbers, main line gas booster station, Monroe, La.



NATIONAL Gas Scrubbers, main line gas booster station, Banquitte, Texas

NATIONAL WET-TYPE SCRUBBERS

54" O.D. x 20' — 750 PSI MAX. WP.
90 MM CU. FT./DAY. 12" INLETS AND OUTLETS

The service required of Wet-Type Scrubbers! Pipe line dust and other foreign materials are removed ahead of compressors at each pressure boosting station. This is done best by passing the gas through a special oil bath in a National Wet-Type Scrubber, then removing the liquid particles from the gas stream when passing through the National Gas Scrubbing element in the top part of the Scrubber.

National Vertical and Horizontal Gas Scrubbers are available in a wide range of sizes, working pressures and capacities to fit the needs of gas producers and carriers.

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NATIONAL TANK COMPANY

TULSA, OKLAHOMA

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PERFECT SEAL
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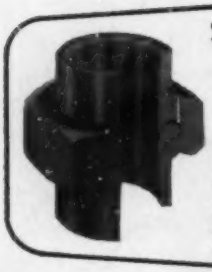
HOT FORGED from solid, rectangular steel bars, designed and produced for dependable, long-life service under the severest piping conditions!

A TYPE FOR EVERY USE!
FOR ALL PRESSURES!
FOR ALL TEMPERATURES!



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UNIONS
Available with screwed or socket weld ends. 3000-lb. sizes 1/8" to 3"; 6000-lb. sizes 1/8" to 2".

ORIFICE UNIONS
With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

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With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.

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LUG NUT UNIONS
Hammer-type for quick opening and quick closing.

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showing the complete Catawissa line of Perfect Seal Products

CATAWISSA VALVE AND FITTINGS COMPANY
60 Mill St. · CATAWISSA, PA.

Stand Makes Fitting Flanges Easy

A fabrication stand that will hold various types of bends while flanges are being fitted is illustrated. The stand is made of a length of channel iron notched at regular intervals along each side. The notches accommodate a clamping device for holding the fabrication firmly in place. The channel iron may be welded to a pipe, channel iron, iron bar or other sturdy base.

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water cans
and coolers
GOTKOOL WATER CAN
Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. Push-Button Faucet at slight additional cost.
GOTKOOL WATER COOLER
Made in 2, 3, 5, 8, 10, 15 and 20 gallon sizes with Push-Button Faucet.
KEEP PURE DRINKING WATER ALWAYS HANDY
GOTT Water Coolers are the convenient way to keep drinking water handy to the worker, protect it from impurities. Their exclusive construction keeps water cool for long periods. Snug-fitting, large, removable top, handy non-leaking push-button faucet. GOTT Water Cans for handy field use. Your supply store has them, get one today!
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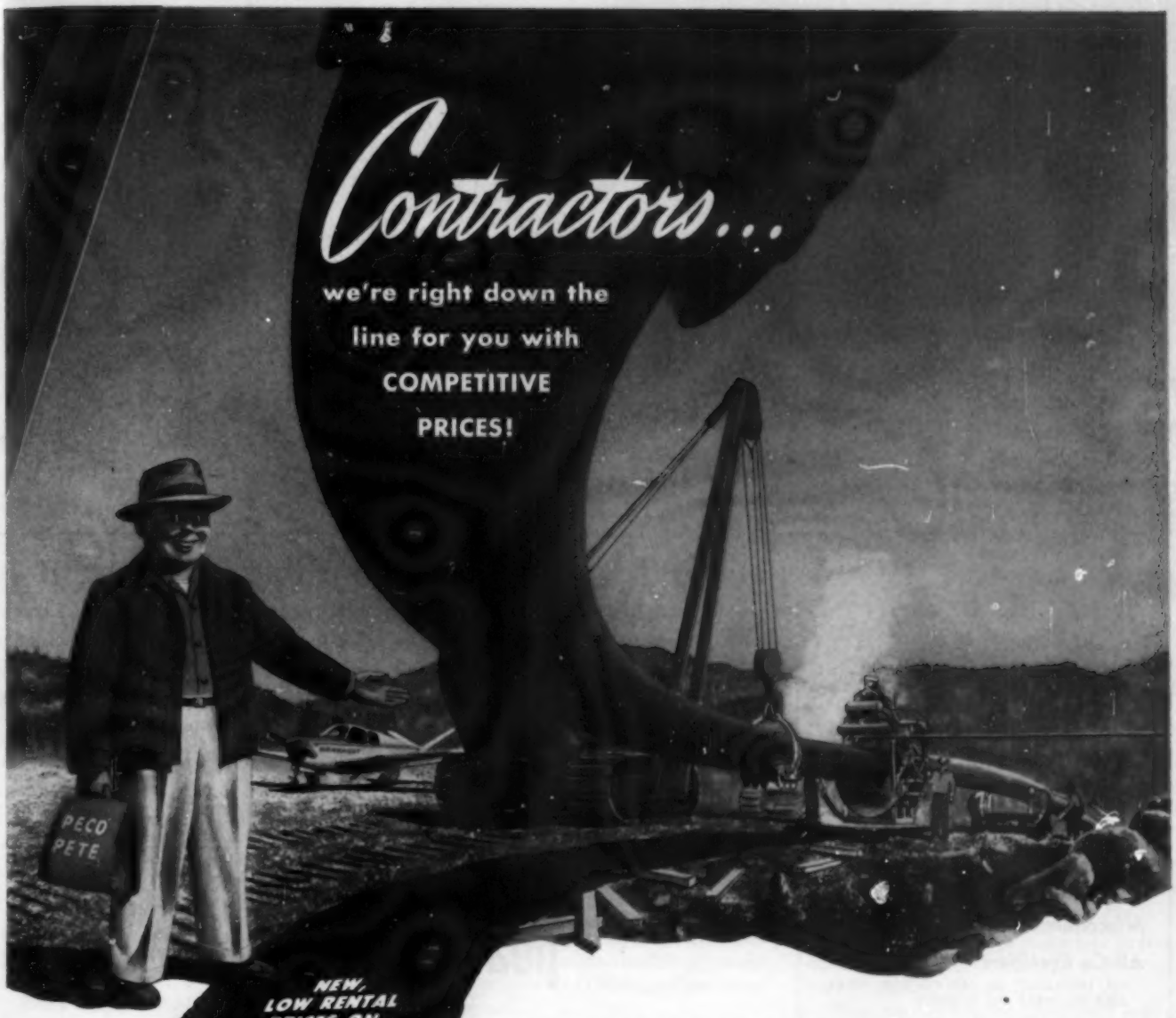
Insist on the Genuine
Gott
WATER COOLER
H. P. GOTT MFG. CO.
WINFIELD, KANSAS



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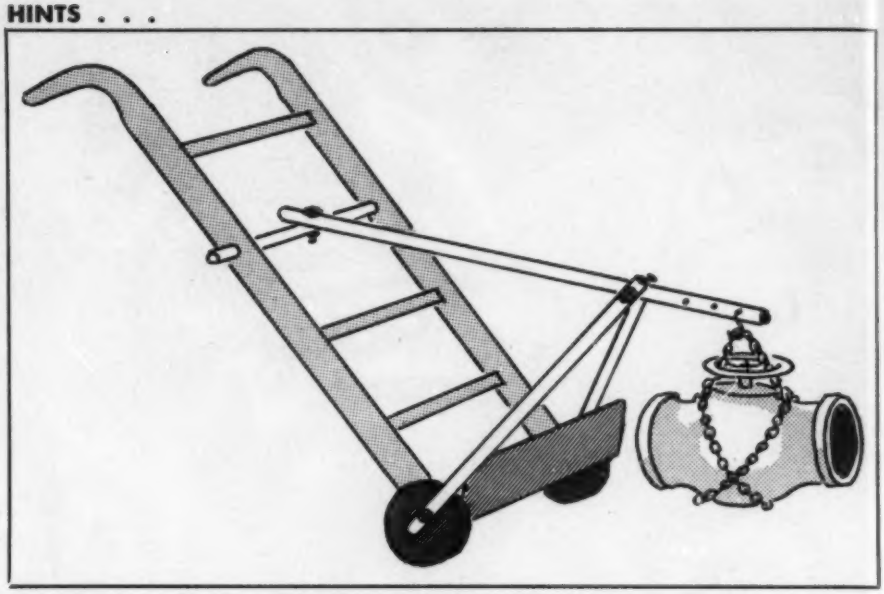
HINTS . . .



Hand Truck Aids in Handling Equipment

A warehouse hand truck equipped with 1¼-inch pipe braces can be used to handle heavy valves and equipment around the warehouse.

The pipe braces shown here are 1-inch and 1¼-inch pipe that can be easily bolted onto any ordinary warehouse truck. The cost of the entire assembly is about $18. It is demountable, permitting dual use of the truck. To make it, replace one of the rungs with steel pipe. Bore or drill a bolt hole through it to attach the long member, as shown.

A short length of chain for wrapping around some items makes a convenient accessory for this tool.

install peak performance into your compressors (AIR • GAS • AMMONIA)

Peak performance, maximum efficiency, greater output, and lower power costs can be built into your oldest, and of course your newest, compressors by the installation of VOSS VALVES.

Check THESE VOSS VALVE ADVANTAGES:

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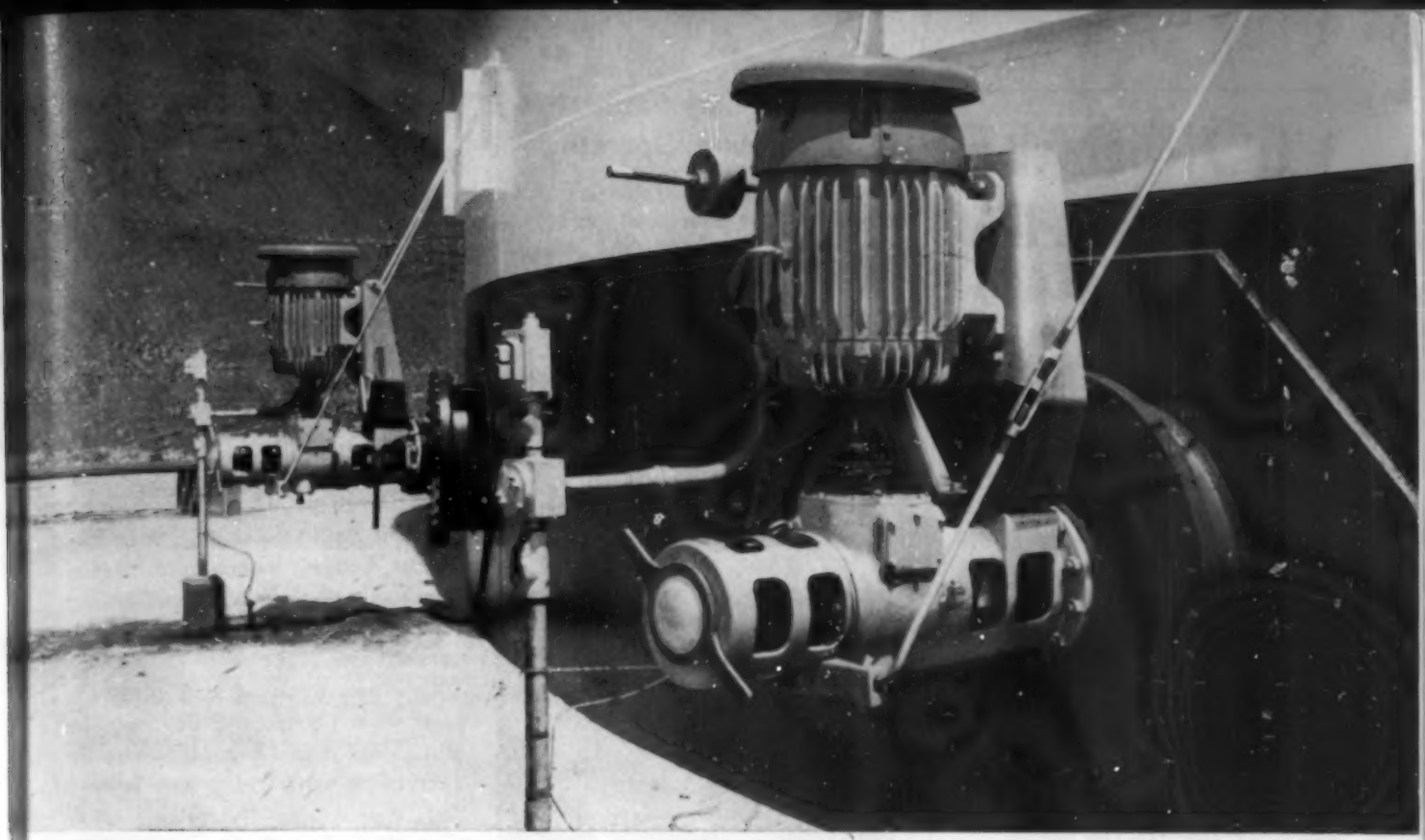
Our detailed proposal for increasing the efficiency of your compressor will be sent you without obligation. Send us the name, bore, stroke, and speed of your machine.

VOSS VALVES / J. H. H. VOSS Co., Inc. 784 East 144th Street, New York 54, N. Y.



NO SEDIMENT in 4½ Years!

Read how a major pipeline company handled 75 million barrels of Kansas crude—with no time out for sludge removal

Ordinarily 5 feet of sediment and paraffin would have accumulated in the 80,000-barrel tank in 4½ years.

But a LIGHTNIN Mixer kept the contents moving, and prevented the sludge-forming fractions from settling to the bottom.

You can easily see how this mixer paid for itself several times over:

1. By eliminating an expensive cleaning job. This would have cost as much as the mixer—just once.
2. By keeping the tank in service—no downtime for cleaning.
3. By keeping the tank's storage capacity at its full value. Five feet of sludge would have reduced capacity by 10,000 barrels.
4. By realizing profits from all merchantable fractions. They were disposed of as rapidly as they were received.

LIGHTNIN Mixers in your crude storage tanks will save you more than their cost in a short time, and will continue to pay dividends for many years.

You take no risk when you buy a LIGHTNIN Mixer. Every LIGHTNIN Mixer is unconditionally guaranteed to do the job you expect of it. Hundreds of LIGHTNINs have been in service 20 years or more.

LIGHTNIN Mixer design makes maintenance easy, too.

Corrosive, abrasive materials in the tank can't hurt bearings—they're safely outside the tank.

You can repack the LIGHTNIN stuffing box quickly under a full head of liquid in the tank, without losing a pint of product.

Or you can eliminate repacking entirely, by using the new LIGHTNIN rotary mechanical seal that requires no adjustment during its lifetime.

Don't let sludge go on stealing your profits. It's easy to plug this profit leak—and scores of pipeline operators are doing it, with LIGHTNIN Mixers. For complete information, call in your LIGHTNIN representative. Or just mail the coupon today.

Lightnin® Mixers

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc.

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Please send me, without obligation:

☐ B-503—Four-page illustrated bulletin giving complete information on B. S. & W. control.

☐ B-104—New 20-page illustrated catalog containing full descriptions, specifications and dimensions of LIGHTNIN Side Entering Mixers.

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FOR SALE
12" LINE PIPE

125,000'—12¾" O.D. .375 wall
49.56 lb. Lapweld

All machine cleaned, commercially straight, 20' single random lengths, ends beveled, used 1st class condition. Suitable installation—oil, water, or gas pipeline systems. 850# to 900# PSI. Large additional quantities, same size, process, taking up, and reconditioning. Priced attractively, for prompt shipments, Welda, Kansas, and Grandview, Mo.

WRITE, WIRE, PHONE

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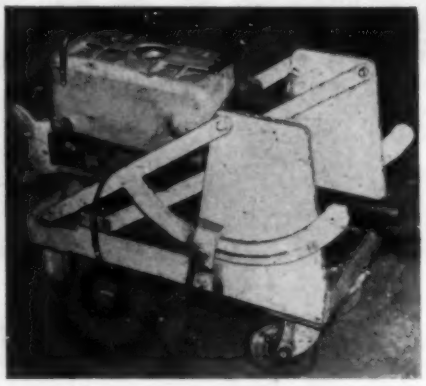
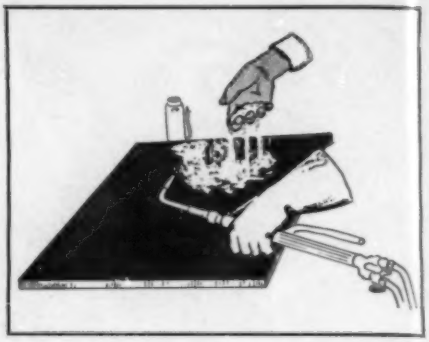
Pipeline Project
125 W. 3rd St., Tulsa, Okla.
Phones 2-9128 — 544229

Mounted Cart Facilitates Pipe Bending Operations

This cart, constructed of sheet steel, is cut to the desired shape with a welding torch. The pipe bending apparatus can be rotated through an angle of about 20 degrees by adjusting the hand crank shown in the foreground.

The well-braced cart is mounted on heavy steel casters to enable easy movement around the shop. The pipe bending apparatus is fitted with a handle to permit fine adjustments on the location of the cart.





Powder on Oily Plates Minimizes Fire Danger

Cutting oily steel plates can be hazardous, because flames from the cutting torch often heat the oil deposits to the ignition temperature quickly causing fires.

One way to avoid such fires is to pour on a portion of dry chemical and spread it in a thin layer over the area to be cut. Unless the layer is thin, it will resist the cutting torch.

By the use of the chemical, flames are extinguished before they can get started, and production remains uninterrupted.

JET-LUBE
KOPR-KOTE
THREAD LUBRICANT and SEAL

HEAT RESISTANT

Avoid leaks in casing and tubing with JET-LUBE's high temperature KOPR-KOTE. Contains fine ground metallic copper. Hundreds of wells cased and tubed without a "leaker." Batch controlled. Fully guaranteed.

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the RIGHT thermometer for your requirements

Shockproof accuracy—easily maintained with a simple external screw adjustment—another Rochester first.

All stainless steel construction including the weld, offers more corrosion resistance. Hermetic sealing protects dials from fogging.

Rochester Model #1850 is recommended for use wherever a straight form thermometer can be used to an advantage. Model 1850 in the standard form has the stem located at the bottom. The stem can also be located at any other position around the entire periphery of the head. Available in stem lengths from 2½" to 48".

For further information on this straight form or other type thermometers—write

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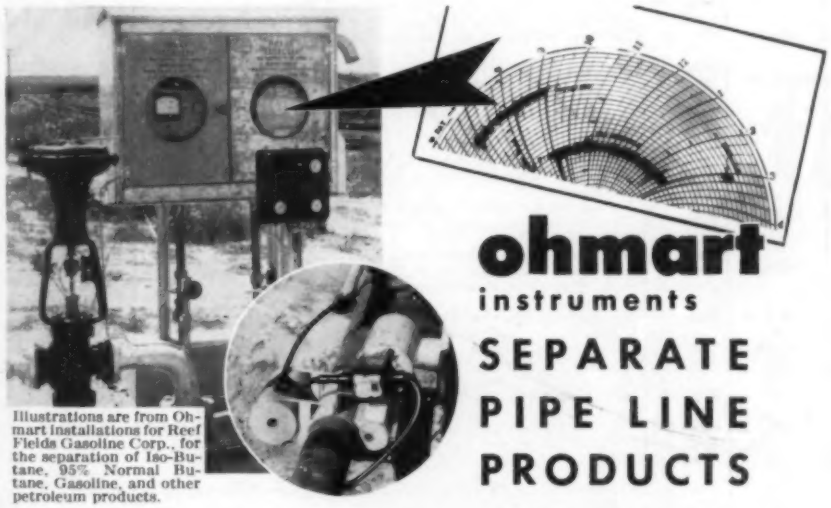
Pipe Line Officials Confer

Division of Transportation officials shown at the annual conference on Pipe Line Technology sponsored by the Division of Transportation of the API are, left to right, Hugh Dishinger, Shell Oil Company's Products Pipe Line Division; John A. deGroot, Tuscarora Pipe Line Company, Ltd.; and L. S. Scherer, Texas Pipe Line Company. More than 400 pipe line experts from the U. S. and abroad attended the meeting at the Warwick Hotel in Philadelphia, May 10-12. deGroot served as chairman of the conference and J. G. Norton, Magnolia Pipe Line Company, was moderator. Participating in the panel were D. L. Rankin, Wyco Pipe Line Company; R. K. Schulze, Shell Oil Company; R. S. Cannon, Plantation Pipe Line Company; E. W. Unrah, Sinclair Pipe Line Company; G. A. Ludwig, Keystone Pipe Line Company; and D. E. White, Magnolia Pipe Line Company. L. S. Scherer, Texas Pipe Line Company, was chairman of the round table discussion. Technical papers were presented the first day, a field trip was made on the second day. The meeting closed with the panel session and round table discussions.



Illustrations are from Ohmart installations for Reef Fields Gasoline Corp., for the separation of Iso-Butane, 95% Normal Butane, Gasoline, and other petroleum products.

ohmart instruments

SEPARATE PIPE LINE PRODUCTS

The Ohmart Pipe Line Monitor is currently in service on both crude and product lines. By continuously measuring and indicating the gravity, interfaces between various products flowing in direct succession through a pipe line are instantly and accurately detected — *without physical contact* to the material being measured! And—no sampling or internal probe required; installation and maintenance extremely simple, with all sensing elements external; no electric power required at point of measurement; automatic controls may be readily incorporated; adaptable to any diameter pipe lines; accuracies obtainable to ± .1° API depending on pipe diameter and span in gravity. Inquire today for full details.

the ohmart corp.
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Southwest Office
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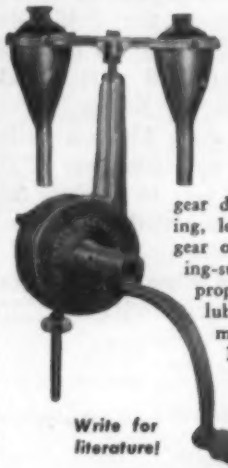
The NEW Protek CENTRIFUGE



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Aluminum alloy castings . . . high strength, light weight. Worm gear drive . . . easier turning, longer gear life. Drive gear of finest bronze. Bearing-supported shafts for proper alignment. Self-lubricated bearings . . . no maintenance necessary. NOW available: Model 152 for 2-15 ml tubes. Model 1002 for 2-100 ml tubes.

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To endure in critical operating conditions, Power Piston Rings must be engineered, produced to withstand constant pressure and develop greater power.

The Centrifugal Casting and "Heat Tensioning" methods used by France have proved: here are Piston Rings that assure you longer life and efficient oil control with no warping or loss of tension in service.

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MAXIMUM SERVICE for you in our NEW PLANT

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WHAT'S HAPPENING

IN PIPE LINE CONSTRUCTION

Pacific Northwest Pipe Line Company is now finalizing its purchase contracts and rushing funding of the line. Engineering on the 1446-mile line from San Juan Basin to Bellingham, Wash., likely will start in 60 days. Construction will follow.

The company owns 150 gas wells and will drill approximately 200 more in the next year to produce 80 percent of its initial gas deliveries.

Anadarko Basin Pipe Line Company has been formed to build a 525-mile 24-inch line from Wise County, Texas, to a point near Memphis, Tenn. The line will begin in North Texas, proceed through the Golden Trend area of Oklahoma, and deliver gas to Texas Eastern Transmission Company facilities near Memphis.

Midwestern Constructors, Inc., has been awarded contract to construct a 230-mile 8-inch products pipe line from Laurel to Glendive, Mont., for **Oil Basin Pipe Line Corporation.** Estimated cost of the line is $5,350,000.

American Pipe Line Corporation has received Office of Defense Mobilization approval for the construction of a $170 million line to run from Beaumont, Texas, to Newark, N. J. ODM granted a 40 percent tax write-off for the company. The line probably will be the world's longest product carrier.

Plans call for the line to be constructed of 24- and 26-inch pipe, giving it an initial capacity of 250,000 barrels a day and a possible ultimate capacity of 500,000 barrels.

Pipe Line Contracts Not Let

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
American Louisiana Pipe Line Co.—666 Penebscot Bldg., Detroit	1289	22 & 30	Gas	Acadia, La.—Near Detroit, Mich.	$130 million	Proposed
American Pipe Line Corp.—New York City (Swinerton & Walberg, San Francisco—Engineering)	1425	24 & 26	Products	Beaumont, Texas area—Newark, N.J.	$170 million	ODM granted 40% tax write-off. Backers working on financing.
Anadarko Basin Pipe Line Co.	525	24	Gas	Wise County, Tex.—To Texas Eastern near Memphis, Tenn.	.....	Planned
Arkansas-Louisiana Gas Co.—Slattery Bldg., Shreveport	136	6 to 24	Gas	Loops along system to increase deliveries to 816 mmcf	$10,072,000	Authorized by FPC 8½ miles already constructed.
Atlantic Pipe Line Co.—260 S. Broad St., Philadelphia	40	8	Crude	Andrews to Midland, Texas	.....	Planned
Badger Pipe Line Co.—Bartlesville	296	8, 10 & 12	Products	Chicago to Madison, Wis.	$15 million	Planned. Pipe being coated.
H. W. Bass & Sons Co.	152	4 & 6	Products	Duval, Live Oak Counties to Corpus Christi, Tex.	.....	Planned
California-Oregon Pipe Line System	103	6	Crude	Crescent City, Calif. to Medford, Oregon	.....	Planned
Carolina Natural Gas Corp.—701 Wilder Bldg., Charlotte, N.C.	185	2 to 12	Gas	Laterals from Transcontinental Gas Pipe Line	.....	Proposed
Central Hudson Gas & Electric Corp.	48	12	Gas	Albany to Kingston, N. Y.	.....	Applied to FPC.
Cities Service Gas Company—1st Natl. Bank Bldg., Oklahoma City	33	20 & 26	Gas	To replace lines in Kansas.	$1,860,000	Proposed
Cities Service Pipe Line Co.—Bartlesville, Oklahoma	60	12	Crude	Sour Lake to Houston, Texas	.....	Planned
Coast Counties Gas & Electric Co.—369 Pine St., San Francisco 4	40	3, 4 & 8	Gas	Coast and Valley region	.....	Planned
Colorado Interstate Gas Co.—Colorado Springs, Colo.	365	22	Gas	Rock Springs, Wyo. to Denver, Colo.	$23,299,000	Authorized by FPC
Colorado-Western Pipe Line Co.—Dallas	708	....	Gas	Southeastern Colorado fields to Denver plus various laterals	$30 million	Planned
	328	....	Gas	LaPlata County—Pueblo, Colorado Springs and Denver	$21.6 million	Planned
Dixie Pipe Line Company	20	8	Gas	Gwinville field, Mississippi to Transcontinental Gas Pipe Line	$425,000	Proposed
El Paso Natural Gas Co.—Bassett Tower, El Paso	32.5	....	Gas	Reagan and Upton Counties, Texas	$799,000	Authorized by FPC
Equitable Gas Co.—420 Blvd. of the Allies, Pittsburgh 19	12	Various	Gas	Marion and Wetzel Counties, W. Va.	$2 million	Authorized
Governments of Southern Rhodesia and Portuguese East Africa	200	....	Products	Beria, Portuguese Mosambique—Umtalia, Southern Rhodesia	.....	Considered
Hope Natural Gas Company—445 West Main St., Clarksburg, W. Va.	33	8, 10 & 12	Gas	Wyoming County, West Virginia—Buchanan County, Virginia	.....	Proposed
	19.9	6—16	Gas	Gathering lines to fields	.....	Proposed
Houston Texas Gas & Oil Company—4604 South Main, Houston	1200	30	Gas	Louisiana—New York	$150 million	Proposed
International Pipe Line, Inc.—227 N. Colfax Ave., Minneapolis	132	8	Products	Wrenshall, Minn.—Minneapolis bulk terminal	$4,250,000	Proposed
Iroquois Gas Corp.—Buffalo, N. Y.	24.5	20	Gas	Erie County, New York	$1½ million	Authorized by FPC
Kansas-Nebraska Natural Gas Co.—Phillipsburg, Kans.	223	6—12	Gas	Central and Northeast Nebraska	$4 million	Authorized
Michi. Inc.	220	10	Crude	Highland, Ind.—Michigan refineries	$6 million	Has ODM certificate of necessity
Michigan Consolidated Gas Co.—415 Clifford St., Detroit 26	25.5	12	Gas	Sparta—Muskegan, Michigan, plus underground storage area	$13 million	Proposed
Michigan-Wisconsin Pipe Line Company—500 Griswold St., Detroit 26	251.9	4—24	Gas	Wisconsin	$11 million	Proposed
Mid-Saskatchewan Pipe Line, Ltd.	23	?	Oil	Smiley field—Kerrobert	.....	Proposed
Minnesota Pipe Line Co.	250	16	Crude	Clearbrook, Minn.—Hastings, Minn.	$12¾ million	Proposed
Missouri Public Service Co.—Warrensburg, Mo.	136.4	8—10	Gas	New Franklin, Mo.—Grundy County, Mo. plus laterals	$5 million	Proposed
Montana-Dakota Utilities Co.	49	12	Gas	Montana, S. Dakota and Wyoming	$1,366,944	Proposed
Natural Gas Pipe Line Co. of America—20 N. Wacker Drive, Chicago 6	240	24	Gas	Cater, Garvin and Stephens Counties—Hutchinson County, Texas	$30 million	Planned
Natural Gas Producers, Inc.—Colorado Springs	100	12	Gas	Yenter pool—Denver	.....	Planned
New River Gas Company	50	?	Gas	Summers—Monroe Counties, W. Va. and Narrows Dublin, W. Va.	.....	Planned
NNCW Pipe Line Company—Dallas	127	8 & 10	Crude	Clareton field—Casper, Wyo.	$3.6 million	Planned
Northern Natural Gas Co.—2223 Dodge St., Omaha, Neb.	167	24	Gas	Farmington, Minn. to Duluth, Minn. and Superior, Wis.	$12 million	Before FPC
	310	24	Gas	Tioga to Fargo, N.D.	$30 million	Planned
	....	....	Gas	To interconnect with Natural Gas Pipe Line	$244,000	Planned
North Dakota Natural Gas Co.—St. Paul	500	10 & 12	Gas	Tioga—Minot, Fessenden, Devils Lake and Fargo, N.D. plus 6" feeder lines	$10.8 million	Proposed
Northwestern Utilities, Ltd.—10124 104th St., Edmonton	42	12¾	Gas	Canada	$1.4 million	Proposed
Orchard Pipe Line Co.—Denver	45	8	Crude	Orchard—Merino, Colorado	$811,000	Planned
Pacific Northwest Pipe Line Corp.—M & M Bldg., Houston	1466	main	Gas	San Juan Basin—Pacific Northwestern states	$160 million	Approved
	380	laterals				
Panhandle Eastern Pipe Line Co.—Kansas City, Mo.	575	New Line	Gas	Kansas—Michigan	$67 million	Before FPC
	398	Loops & Laterals	Gas	Kansas—Michigan		

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
Pembina Pipe Line Co., Ltd.—Calgary	325	3—12	Crude	Pembina field—Edmonton	$5½ million	Preliminary
	72	16		Transmission	$13 million	Permit granted
Petroleos Mexicanos—Ave. Juarez 94, Mexico City	440	20	Nat. Gas	Brazil—Tampico—Posa Rica, Mexico	.....	Planned
	260	6 & 8	Products	Lagos, Mexico—Guadalajara, Aguascalientes and Salamanca	.....	Planned
	145	12	Crude	18 de Marzo field—Monterrey, Mexico	.....	Considered
	100	....	Crude	Isthmus of Tehuantepec, Jose Colomo—El Plan field, Minatitlan	.....	Planned
	72	12	Crude	Posa Rica—Atzacapotzalco, Mexico	.....	Proposed
Phillips Petroleum Company—Bartlesville	52	10	Products	Shell's Brookshire system—Sweeny, Texas	.....	Planned
	54	6	Products	Goldsmith—Borger, Texas	.....	Planned
	44	10	Products	Paola, Kansas—East St. Louis	.....	Planned
Pine Tree Natural Gas Company	204	undetermined	Gas	Boston area—Bangor, Maine	.....	Planned
Pittsburgh Consolidation Coal Co.	100	....	Coal	Cadiz, Ohio to near Cleveland	$10 million	Planned
Progress Pacific Pipe Line Co.—530 West 6th St., Los Angeles 17	1100	24	Crude	Odessa, Texas—Los Angeles Harbor	.....	Planned
Shamrock Oil & Gas Corp.—1st Natl. Bank Bldg., Amarillo	55	6	Products	McKee—Amarillo, Texas	$1 million	Planned
Shenandoah Gas Co.—Lynchburg, Va.	40	....	Gas	Virginia Gas Transmission Co. System—Virginia and W. Virginia towns	$1½ million	Authorized
Sinclair Pipe Line Co.—Pure Oil Co.	494	18—20	Crude	Colorado to Kansas.	$25 million	Announced and Authorized
Socony-Vacuum Exploration—Woodley—Canadian Oil Co.	155	16	Crude	Festerton, Sask. to Regina, Sask. Canada	.....	Planned
South Georgia Natural Gas Co.	220	Various	Gas	Lee County, Ala.—Georgia and Florida	$8,969,000	Proposed
Sunflower Pipe Line Co.—Tulsa	265	3 to 6	Products	Kearny, Grant and Haskell counties, Kansas to Wichita, Kansas	$3½ million	Planned
Standard Oil Co. of Texas	250	....	Products	El Paso to Albuquerque	$4 million	Surveying
Tennessee Gas Transmission Co.—Box 2511, Houston 1	50	10	Gas	Nueces County, Texas	.....	Proposed
	243	24	Gas	Hebron storage field, Penn.—N.Y.—Connecticut line	.....	Proposed
Texas Eastern Transmission Corp.—Texas Eastern Bldg., Shreveport	329	16 & 24	Gas	Reconvert "Little Big Inch" line from Beaumont, Tex., to 81,100 East Coast to oil transportation to gas	$78.8 million	Proposed
Texas Gas Transmission Co.—416 W. Third St., Owensboro, Kentucky	48	26	Gas	Lake Cormorant, Miss.—Slaughter, Ky.	$4¼ million	Proposed
Trans-Canada Pipe Line, Ltd.	2240	30 & 36	Gas	Alberta—Eastern Canada	$300 million	Approved
Transcontinental Gas Pipe Line Corp.—3100 Travis St., Houston 6	57	30 & 36	Gas	Parallel existing system in Louisiana, Mississippi and Alabama	$6½ million	Authorized by FPC
	....	....	Gas	Connecting facilities with Texas Eastern-Penn Jersey Trans. Corp. at Montgomery County, Pa., and Linden, N.J.	$131,628	Authorized by FPC
	533	30 & 36	Gas	Paralleling portions of Texas—New York Line	$80 million	Proposed
Triangle Pipe Line Company	560	12	Products	Arkansas City, Kansas—Covington, Kentucky	$24½ million	Proposed
Union Oil Company of California—Union Oil Bldg., 617 W. 7th, Los Angeles 17	60	?	Crude	Santa Clara valley field—Wilmington, refinery	.....	Proposed
United States Corps of Engineers	375	12	Products	St. Nazaire—Melun and Metz, France	.....	Planned
	600	....	Products	Under study to supply naval base and four air bases in Spain	$16 million	Under Study
West Coast Pipe Line Co.—Mercantile Bank Bldg., Dallas	960	24 & 26	Crude	Wink, Texas—Norwalk, California	$106,000,000	Planned
Williston Basin Pipe Line Co.—Insurance Bldg., Omaha	244	8	Products	Billings and Laurel refineries—Glendive, Mont.	.....	.....
Yacimientos Petroliferos Fiscales Bolivianos	170	4	Crude	Bermejo—Tupinza, Boliva	.....	Planned

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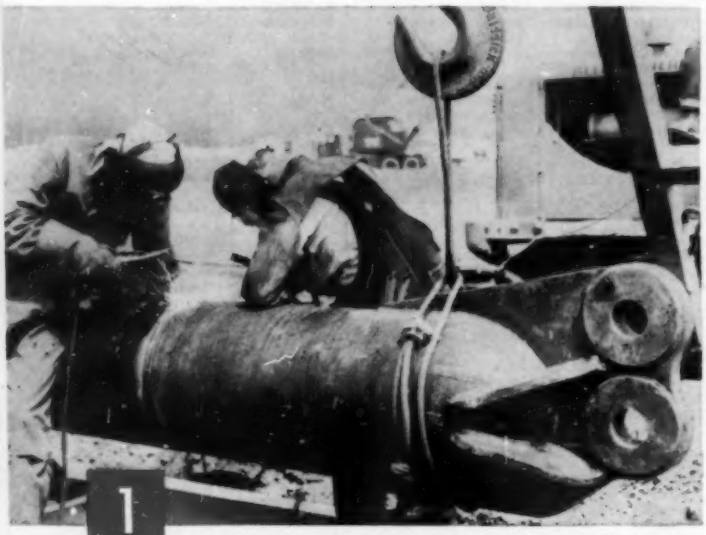
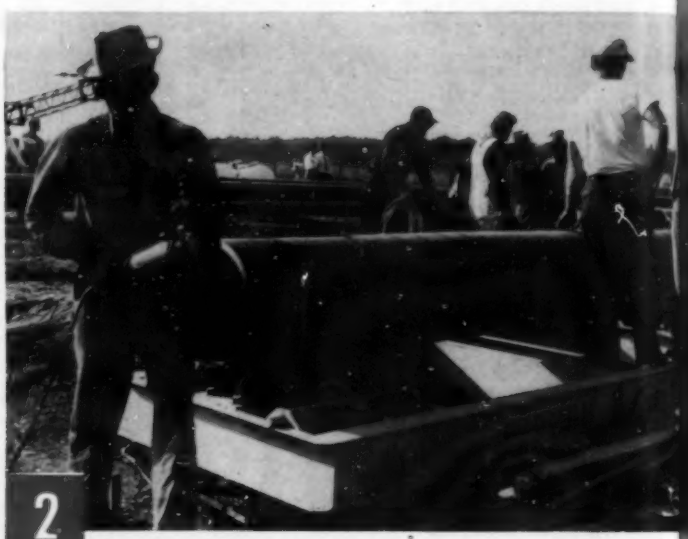
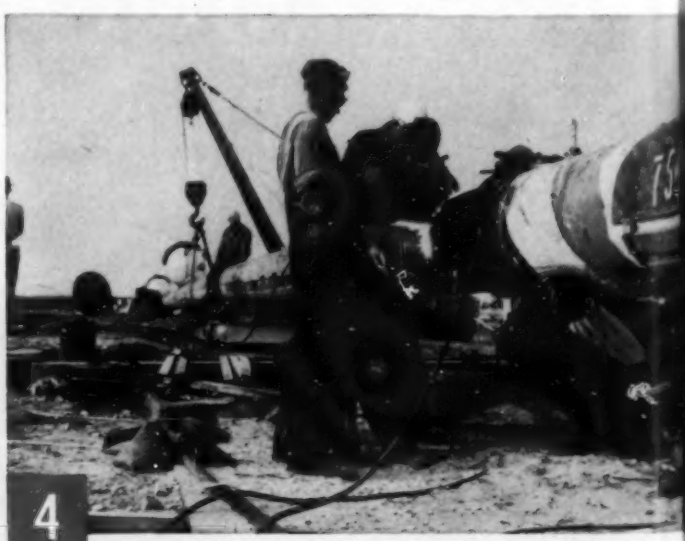


1 **"OLD BULLHEAD,"** the watertight pulling dome, being welded to the first length of pipe. The 4-mile pipeline was pulled across the Straits by a powerful winch which was set in a concrete foundation approximately 2,700 feet from the water's edge on the Mackinaw City side.



2 **A SECTION** of the extra-heavy $1\frac{13}{16}$-inch wall National Seamless Pipe being prepared for welding. The pipe is resting on one of the Collins rubber-tired launchways.

3 **THE FIRST SECTION** of pipe ready for launching at St. Ignace, Michigan. On the water, in the background, is a dredge which assisted in the pulling operation. At the left is the Control Tower, nerve center of all operations during the "Big Pull."



4 **MAKING A TIE-IN WELD** between two of the 2500-foot sections of National Seamless. As each section was launched, a new section was welded to it, until all eight 2500-foot sections had been welded into one continuous 20,000-foot line of National Pipe.

WALLS WITHOUT WELDS

"BIG PULL"

st submarine pipeline crossing

SOUND planning, a world of technical know-how, and the utmost care in selection of materials made possible the "Big Pull"—Lakehead Pipe Line Company's two 20-inch crossings of the 4-mile wide, 250-foot-deep Straits of Mackinac—the deepest and longest submarine lines ever laid.

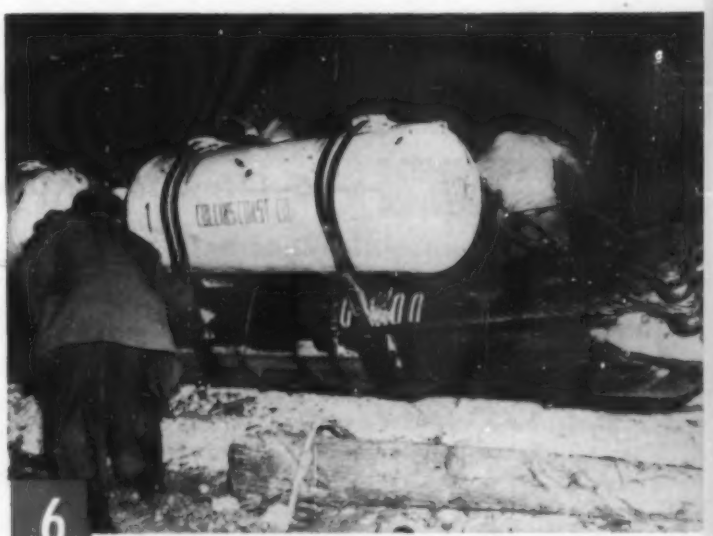
Ingenious systems and devices had to be created for dredging, launching the pipe, adding buoyancy, pulling the pipe, filling it, and releasing the pontoons after the pipe was laid. Bad weather and rough water had to be overcome. The work, both ashore and afloat, had to be closely synchronized via a radio-telephone network, providing constant two-way communication as the pull progressed. And, of utmost importance, the pipe used had to have the unusual combination of high strength, extreme flexibility and maximum uniformity. It had to resist great pressures, absorb distorting and bending stresses; it had to have superior welding qualities; and for years to come it will have to be "trouble-free"—completely dependable. National Seamless Steel Pipe met these requirements and was the ultimate choice.

Twenty-seven foot lengths of 20-inch OD National Seamless Pipe, 13/16-inch wall, were welded into eight sections, each approximately 2,500 feet long and weighing 220 tons. The pipe was coated and wrapped with two layers of fibre glass matting, and the lower perimeter was sheathed with timber lagging to protect it from possible damage as it scraped the bottom of the Straits.

The first of the two 4-mile sections of pipe was pulled across the Straits in just less than seven days. The second crossing was accomplished in only 65 hours and 5 minutes. Bechtel Corporation of San Francisco, California, as the agent for the Lakehead Pipe Line Company, Inc., managed the history-making crossing, which was completed by Merritt-Chapman & Scott Corporation, general marine contractors; and Collins Construction Co. of Victoria, Texas, submarine pipeline specialists.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION
PITTSBURGH, PA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

5 **STRAPPING FLOAT** to section of 20-inch pipe being pulled across the Straits. Floats were placed at 66-foot intervals to prevent heavy pipe from dragging on the bottom. With floats attached, pipe had a negative buoyancy of six pounds per foot.



6 **"OLD BULLHEAD,"** just after it emerged from the water at the south shore (Mackinaw City) landing site. It was greeted with triumphant shouts and a champagne christening by executives and employees involved in the operation.

USS NATIONAL SEAMLESS PIPE AND TUBES USS

UNITED STATES STEEL

Rules of Thumb

FOR THE PIPELINER'S NOTEBOOK

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These formulae from the pages of engineers' own notebooks yield rough, but reasonably accurate answers for design, maintenance and supply questions. The Editors will pay $15 for your pet Rule of Thumb.

Send your Rule of Thumb to Donald M. Taylor, Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1.

Pipe Line Construction

—12—How to determine the degrees of bend in a pipe which must fit a ditch which calls for a bend in both horizontal and vertical planes.

Rule: To find the number of degrees in the combination bend, square the side bend and the sag or overbend; add them together and extract the square root. The answer will be the number of degrees necessary to make the pipe fit the ditch.

Example: Determine the bend to make in a pipe whose ditch has a 3° overbend and a 4° sidebend. Let X = the unknown angle:

$X^2 = 3^2 + 4^2$

$X^2 = 9 + 16$

$X^2 = 25$

$X = 5°$

Example: Determine the bend to make in a pipe whose ditch has a 9° sag and a 12° sidebend. Let X = the unknown angle:

$X^2 = 9^2 + 12^2$

$X^2 = 225$

$X = 15°$

Engineering Design

—16—How to calculate the weight of gas in a pipe line.

Rule: Find the volume of the pipe in cubic feet and multiply by the weight of the gas per cubic foot. To find the latter, multiply the absolute pressure of the gas times 3 and divide by 1000.

The basis for the latter is that gas with a specific gravity of .60 at 70° F. weighs 3.06 lb./cu. ft. at 1000 psia. And everything else remaining equal, weight of the gas is proportional to absolute pressure. Thus to find the weight of gas at, say, 500 psia, multiply $3 \times \frac{500}{1000} = 1.5$ pounds. (1.53 is more accurate.)

Example: Find the weight of gas in a 1250-foot aerial river crossing where the average pressure reads 625.3 on the gauges; and temperature of the gas is 70° F. and specific gravity of gas is .60.

Solution: Change psig to psia: 625.3 + 14.7 = 640 psia

Weight of gas per cu. ft.

$$3 \times \frac{640}{1000} = 1.92 \text{ lb./cu. ft.}$$

Volume of 100 feet of 23¼-inch ID pipe = 3688 cu. ft.

Weight of gas = 7081 pounds.

This method is fairly accurate; here is the same problem calculated with the formula:

$$W = \frac{(V)\ (144)\ (P_{abs})}{R\ T}$$

Where W = weight of gas in pounds; V = volume of pipe; P_{abs} = absolute pressure of gas; R = universal constant 1544 ÷ molecular weight of gas; and T = temperature of gas in degrees Rankine. (To find the molecular weight of gas multiply specific gravity × molecular weight of air, or in this case, .6 × 28.95 = 17.37)

$$W = \frac{(3688)\ (144)\ (640)}{(1544 \div 17.37)\ (70 + 460)}$$

$W = 7213$ pounds

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High pressure gas transmission on pipelines calls for equipment that's dependable as well as efficient. That's why De Laval centrifugal compressors have been chosen for these and many other booster stations.

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De Laval units, totaling 200,000 hp, are now in operation on major pipelines. De Laval engineers will be glad to give you the benefit of their wide experience in this field.

TRANSCO selected these three De Laval 5,000 hp steam turbine-driven centrifugal compressors for their Tylertown, Mississippi station.

EL PASO—These 30-inch De Laval centrifugal compressors are on the job at El Paso's Florida station. In addition, they have nine more De Laval units in use at other stations.

TEXAS EASTERN—The thirteen 2,500 hp centrifugal compressors on this company's 30-inch gas pipeline from Kosciusko, Mississippi, to Uniontown, Pennsylvania, are all De Laval.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY

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PIPE LINE INDUSTRY'S VIEWS OF THE NEWS

HEADLINES OF THE MONTH

• High court makes unwilling bookkeeper of FPC . . . • State-federal conflicts expected . . . • Gas act exemptions rule criticized . . . • OWIU stages juggling act . . . • Railroads spend $400 million on petroleum products . . . • Demand for all oils up . . .

FPC: Unwilling Bookkeeper

The Supreme Court last month made a bookkeeping agency of the Federal Power Commission and natural gas companies of 2500 independent producers.

In ruling, 5 to 3, that Phillips Petroleum Company's sales of natural gas to interstate pipe line companies are subject to regulation by FPC, the court was decreeing that the commission must no longer shrink from its rate-making authority over independent producers whose sales to interstate lines have heretofore been free from government intervention.

The court said, in a majority opinion by Justice Minton, that it was satisfied that when Congress passed the Natural Gas Act it sought "to regulate wholesale natural gas occurring at both ends of the interstate transmission systems."

As a company which sells gas it has produced itself or gathered from other independent producers, Phillips had joined FPC in arguing that it is not a natural gas company within the meaning of the Natural Gas Act and therefore is not within the commission's rate-making jurisdiction. Phillips and FPC granted that the company makes sales to interstate pipe line companies, but argued that these sales are a part of production and gathering.

The Court, however, said production and gathering phases had already ended by the time Phillips made its sales to pipe line companies.

In a scathing dissent Justice Clark, with Justice Burton concurring, said that perhaps Congress should have given FPC control over production and gathering, but that Congress had specifically exempted those categories. Yet, they said, in face of this specific exemption by Congress, the Court majority had issued an opinion that, on its face, "brings every gas operator, from the smallest producer to the largest pipe line, under federal regulatory control."

It is exactly this regulatory headache that FPC was attempting to avoid when it held in 1951 that it had no jurisdiction over Phillips' gas sales. (The State of Wisconsin and the cities of Milwaukee, Detroit and Kansas City disputed this decision before the Court of Appeals, which reversed FPC. Phillips, FPC and the State of Texas then appealed the court's decision. The High Court first refused to review the case, then reversed itself and accepted the suit.)

The first migraine FPC must suffer is to determine how far the ruling extends. Are there some points unique to Phillips? Does it completely cover the 2500 independents who sell to interstate pipe line companies? Does it cover the approximately 15,000 independent producers of oil who have some gas production and at some future date may want to sell to an interstate company?

To clarify these points, FPC must consult the courts. Next, the commission would have to recruit accountants and a field staff to study the operations and books of each producer within its jurisdiction. Earnings would have to be ascertained; rate schedules would have to be issued.

Then an attempt would have to be made to segregate oil income from gas income in order to learn what earnings each producer derives from its gas. Finally each producer would have to decide whether to establish a separate company to handle its gas operations.

Chances were, before FPC got around to shouldering the entirety of its impossible burden, Congress would have taken it out of the bookkeeping business by passing legislation saying what the Natural Gas Act tried to say 16 years ago. But there can be no such relief this year—first, because time is short, and second, because Congressmen from consumer states would risk having their political pants burned off if they snuggled up to so flaming an issue in an election year.

However, it appeared last month that a delay in the legislation won't cause the confusion to be compounded by precipitate action from FPC. The commission was approaching its onerous task at something less than a dog-trot. Commissioner Draper said FPC would probably start an investigation, including public hearings, as soon as possible to determine whether Phillips' present rates are fair and reasonable. He indicated this would probably be the first specific case in which the commission exercises its new authority over the independents.

Conflicts Likely

Once FPC goes into action, it will likely run afoul proration laws. Chairman Ernest O. Thompson of the Texas Railroad Commission visualized a situation like this: Gas from a given well is tied up under a long-term contract to an interstate pipe line, which would make it under FPC jurisdiction. However, the state regulatory body might find that the gas should be returned to the producing horizon to maintain pressures.

Another state-federal conflict would be brought about by the minimum price law suggested by President Jack Woodward of Texas Independent Producers and Roy-

Oil Lines Growth Cited

The fabulous spread of oil pipe lines since World War II was measured last month by the Bureau of Transport Economics and Statistics of the Interstate Commerce Commission.

The Bureau reported that transportation revenue of large oil pipe line companies was 118.7 percent greater in the first quarter of this year than in the corresponding period for 1946. For the same period there was an increase of 81.5 percent in quantity.

The figures were based on quarterly reports of oil pipe lines having revenues of more than $500,000 annually.

Transportation revenue of these companies was $142 million in the first three months of 1954, compared with $64.5 million in the same period of 1946. In volume, this year's figures were 891 million barrels as against 490.8 million for the first quarter of 1946.

The report showed traffic volume in the first quarter was 1.5 percent over the same quarter of 1953, and revenues were up 4 percent.

alty Owners Association. If the FPC ceiling collided with the Texas floor, the courts would be needed to pry them apart.

This probability of jurisdictional conflict was seized upon by Phillips in its quick plea to the High Court for reconsideration. The company pointed out that the court failed to define an existing division of constitutional powers between the federal government and states, thus leaving "the Federal Power Commission, the states and the industry with no legal landmarks to guide them."

Another petition was filed by the States of Texas, Oklahoma and New Mexico, asking the court for a ten-day extension of the deadline for requesting reconsideration of the decision. Presumably, the extension was asked to allow consideration as to the best approach for a reconsideration plea.

Another plea went to President Eisenhower from Senate Minority Leader Lyndon Johnson (D., Texas), who asked that a special commission make a study of the Phillips case and recommend legislation. The commission would include representatives of the Federal Power Commission, gas industry, state oil and gas regulatory groups, and "private citizens."

Johnson's plan, while slower, seemed to hold far greater promise of success than a direct appeal to the court. The Texas senator knows every ramification of the problem and was partly responsible for congressional acceptance of the Kerr Bill four years ago. On that occasion he was given unforgettable proof of the necessity of backing from a president who will stand hitched (as Truman didn't).

Other Regulating Moves

Evidence of the widespread efforts to regulate the oil and gas industries cropped up in other directions last month:

• The House Commerce Committee opened hearings on a bill to authorize FPC to prescribe safety standards for natural gas companies. FPC has endorsed the measure as being in the public interest. Frederic A. Hough, chairman of an industry code committee and vice chairman of Southern Counties Gas Company of Los Angeles, urged the committee to delay action until completion about December 1 of a new safety code for the natural gas industry. He predicted that voluntary compliance will make federal regulation unnecessary.

• The Massachusetts Legislature rejected measures to make gasoline and fuel oil prices subject to approval by the Department of Public Utilities.

Exemptions Rule Scored

The amity between industry and the FPC on the principles involved in the Phillips case was in contrast to another jurisdictional debate being waged last month.

The opinion that the FPC is going beyond the intent of Congress by insisting on applications for exemption from provisions of the Natural Gas Act was voiced by industry leaders.

J. French Robinson, president of the Consolidated Natural Gas Company of New York, pointed out at the Eastern district API meeting that the Bricker-Hinshaw amendment, signed into law by President Eisenhower last March, provides for exemption from regulation by the FPC of companies engaged solely in intrastate operation and regulated by state utility commissions.

Under a proposed rule issued by the FPC, Robinson said, a company wishing to claim exemption from regulation under the Bricker-Hinshaw amendment must apply to the commission for an order granting exemption from the act. Robinson declared the gas industry's position is that the Natural Gas Act is not applicable to a company engaged in intrastate operation and already regulated by a state commission. "Hence," he asserted, "no granting of an application by the commission is . . . necessary . . ."

Safety Award Offered

The API performed another service to the industry last month by establishing a Meritorious Safety Award to recognize

INDEX
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SEC. 2 ★ RECTIFIERS
SEC. 3 ★ CABLE & ACCESSORIES
SEC. 4 ★ INSULATION MATERIALS
SEC. 5 ★ PROTECTIVE TAPE COATING
SEC. 6 ★ INSTRUMENTS & ACCESSORIES
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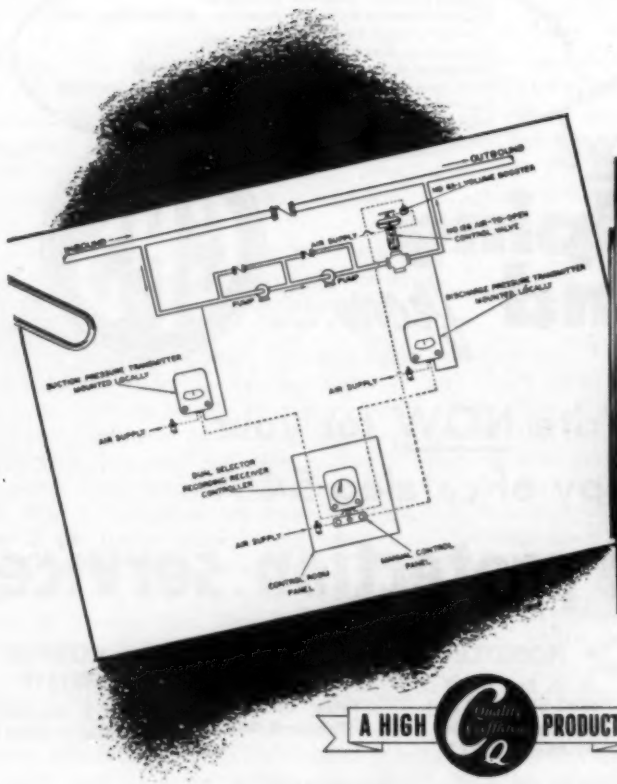

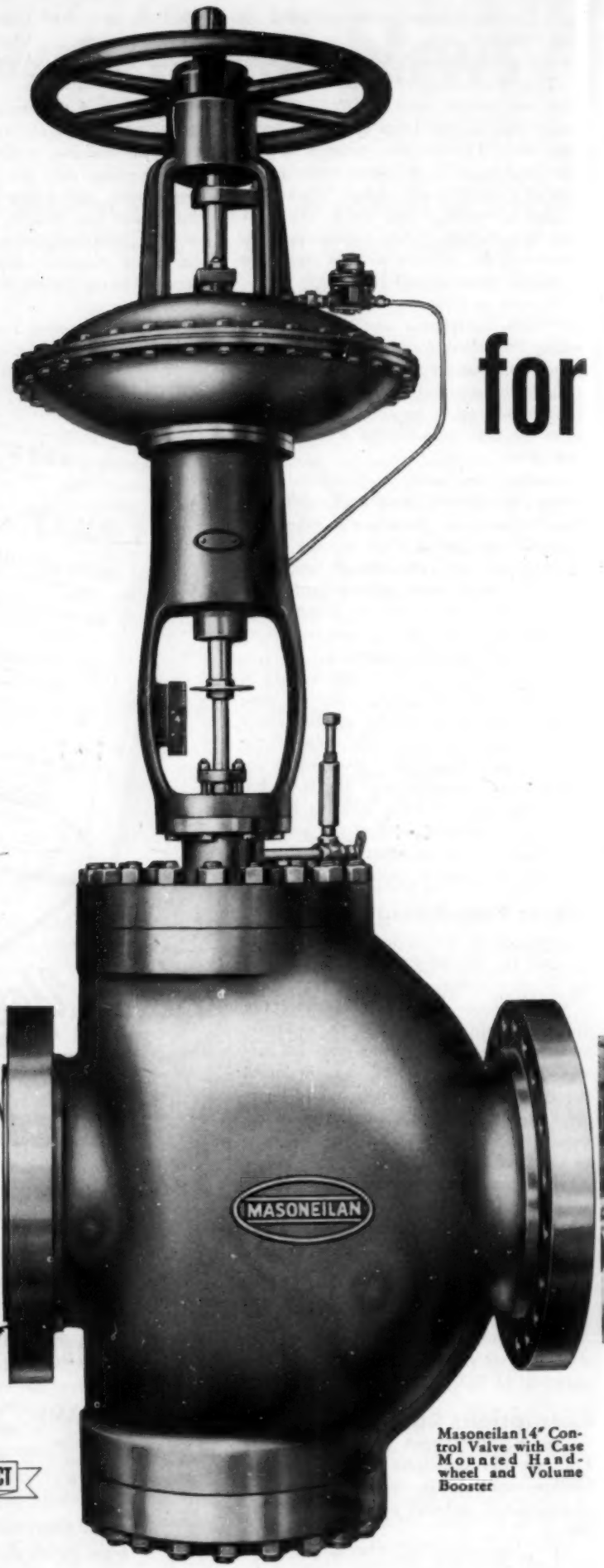

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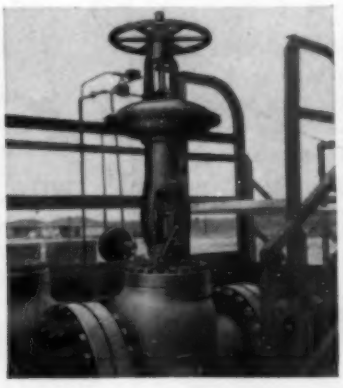

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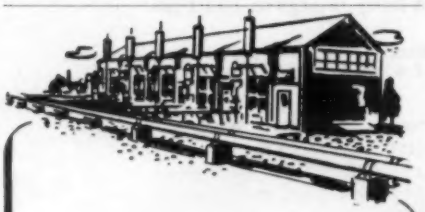

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outstanding acts of heroism and first aid in the petroleum industry.

The award consists of a certificate citing details of the act, a medal encased in a transparent block of lucite, and a lapel pin. The certificate is to be signed by the president of the Institute and the head of the employe's company.

Only those acts performed since January 1, 1953, will be recognized. Qualifications state that "any person affiliated with the petroleum industry who, in the line of his duty or off the job, saves a life either because of an act of heroism which involved the risk of his own life, or because of the successful administration of first aid" is eligible.

OWIU Stages Juggling Act

Like a singing juggler with four balls in mid-air, the Oil Workers International Union set up a chant for a 5 percent wage hike and a big new labor organization last month while simultaneously attempting to soothe management, entice independents into the field, lull the fears of rival unions, and draw tighter the bonds within its own rank and file.

Main acts of the week-long OWIU show were:

• The demand that about 11.25 cents be tacked onto the worker's average hourly wage of $2.25; and

• The delivery of the 130,000-member Oil Workers International Union to the burgeoning Oil and Chemical Workers Union, which was conceived of the despair among OWIU leaders of ever achieving nationwide bargaining with the present limited membership.

But the flashiest performances came in the one-man side shows staged by President and Chief Prestidigitator O. A. (Jack) Knight, who tossed up a cluster of placatory broadsides.

For management's benefit, Knight delivered the unprecedented promise that his union would not strike, threaten to strike, or take a strike vote during wage negotiations. However, the promise does not apply to issues other than wages, and the way was left open to revoking the promise in the event that talks do not progress satisfactorily.

Further, said Knight, employers will learn to cherish the new union as a trouble-stopper (see below).

Turning to the independents, many of whom have accused OWIU of sponsoring this new union as a means of gobbling them up, Knight urged them to take their time about ratifying the new organization. "We want all the unions and their members to have time to study the matter carefully and to understand it well before they take any action," he declared in an effort to avoid being accused of high-

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pressuring the small groups. However, he followed this pronouncement with a veiled warning that charter memberships in the new setup won't be open forever. A merger convention will not be called until several other unions have approved, he declared, but proceedings won't be held up until the new organization is approved by all 31 unions represented at the initial meeting in Philadelphia early in the year.

(Some independents immediately began falling in line. The first of 26 locals of Central States Petroleum Union to vote on the merger approved it by 571 to 375.)

For rival unions fearful of the big new union, Knight also had a soothing gesture. A "no-raiding" pact was discussed with representatives of the AFL Teamsters Union, which has concentrated on service stations, whereas OWIU has directed its efforts into other fields.

Not overlooked by Knight in the distribution of blandishments were the rank-and-file of his own OWIU, traditionally one of the most fiercely democratic in American labor. Harmony during this touchy period was assured, insofar as he could assure it, by permitting the locals to work out such matters as a shorter work week and improved pensions. Even the 5 percent wage hike goal may be increased by locals under "special" circumstances, Knight declared.

Basis for Pay Demand

In lining up arguments for a pay increase, OWIU led off with an old reliable: Increasing productivity.

"While the number of workers employed by the oil industry is steadily declining," said the policy committee, "the volume of production, the volume of sales and the net profit of the oil companies continue to increase."

Then came a somewhat breathless flyer into elevated economics: Increasing productivity in general.

"Throughout our economy," was the lofty explanation of what's this got to do with it, "production is increasing—at a much faster rate than consumption. Increased wages are needed to stimulate purchasing power and thereby provide a market for the increasing flow of consumer goods."

The final argument was back on the rank-and-file level: Insufficient compensation for the skills of oil workers.

"The application of elaborate new equipment, electronic controls and other automatic devices in the oil industry requires an ever higher level of skill on the part of oil workers.

"Oil workers' wages, while high in relation to those in some other mass production industries, are in many cases low in relation to the skills required."

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RIDGID 4P is easy to carry, easy to put on pipe

Balanced loop handles make it a cinch to carry and swing up on a pipe! Besides, the mistake-proof workholder sets to size before you lift it—only one screw to tighten on pipe. Easy upkeep—drive pinion in oilless bronze bearing; safe enclosed gear. 4 sets of 5 high-speed steel dies, 2½", 3", 3½", 4". Ratchet handle. RIDGID drive shaft available. Save work—buy 4P at your Supply House.

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ROACH TIMER Model TYC 101

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WRITE FOR NEW BULLETIN #101

ROACH
EQUIPMENT COMPANY
BOX 1067 TULSA, OKLA.

Knight Caught off Base

Jack Knight's zeal to slide home with an organization of all industry workers caused him to get caught off third base last month. Knight declared that industries which recognize strong national unions have less labor trouble than "half-organized" industries. "Sure," he said, "there is a lot of publicity when steelworkers strike or when General Motors is shut down by the auto workers, but over the years I dare say these companies lose less production than those industries which have a muddled bargaining situation—such as oil." Whereupon the National Petroleum Association's weekly news bulletin replied with figures for 1945-52, inclusive, from the Bureau of Labor Statistics:

Industry	Number of Strikes	Man-days Idle
Bituminous	4019	65,924,000
Basic steel	869	43,828,000
Automobiles	869	35,961,000
Petroleum Refining	90	3,155,300

Railroads Big Buyers

The American railroads are among the country's top customers of the petroleum industry, according to a compilation on corporate expenditures by the Association of American Railroads.

The study shows Class I railroads spent about $400 million for petroleum products in 1953 and they expect to maintain such purchases as more lines dieselize equipment.

Other highlights show that fuel for train operations accounted for the biggest portion of railroad purchases. The sum spent on diesel, residual fuel oils and gasoline amounted to approximately $355 million, or 88 percent of the total expended by the carriers for all kinds of fuel.

Railroad purchases of diesel oil alone in 1953 came to $300 million, an increase of $38 million over the 1952 period, and spending for residual oil totaled $45 million, while more than $10 million was spent for gasoline.

The railroads also paid out an additional $42 million in 1953 for lubricating oils, greases, boiler compounds and related oil products.

American railroads purchase about half of the diesel oil consumed by the nation. Dieselization of rail motive power has progressed so far that diesel locomotives handle 80 percent of all railroad service.

The Interstate Commerce Commission reported in 1953 that railroads had originated 45 million tons of petroleum and by-products and those shipments over the railroads consisted of more than 12 million tons of fuel and road oils; 11½ million tons of gasoline; 9.2 million tons of other refined products; 4.7 million tons of asphalt; 3.9 million tons of lube oil and greases, and 3.8 million tons of crude petroleum.

PIPE LINE MATERIAL SUPPLY

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MAC-IRON offers a complete listing of line and temporary strainers. The latter of woven wire, perforated basket and conical . . . all for use with raised face, and ring joint flanges.

A large stock on hand is maintained; special strainers made to specification. Write direct for a catalog and complete information.

The Mack Iron Works Company
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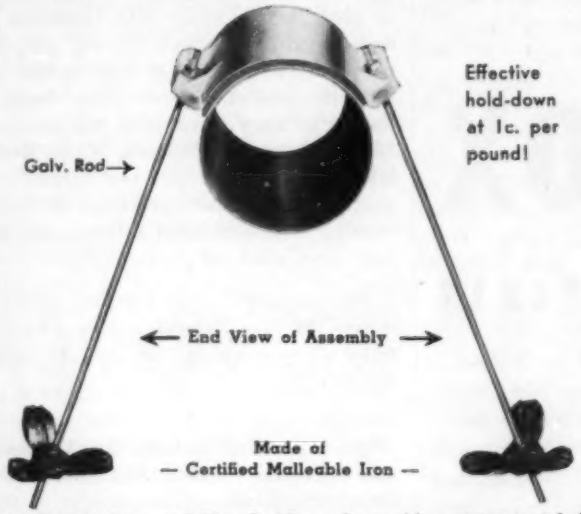
Grip-Tite

Pipe Line Anchor Assembly



Grip-Tite Anchors and Pipe Saddle make positive, permanent hold-downs for all kinds of pipe line construction through marshy, swampy or flooded lands. They eliminate the need of cast iron or concrete weights, save time, money and handling expense. They're field proved beyond any doubt.

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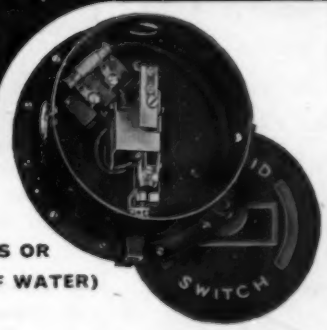
DIFFERENTIAL PRESSURE CONTROLS FOR LOW PRESSURES

MERCURY SWITCH EQUIPPED



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TO OPEN OR CLOSE AN ELECTRICAL CIRCUIT ACCORDING TO A MINUTE CHANGE IN THE DIFFERENCE BETWEEN TWO PRESSURES OR VACUUMS

Mercoid Type PPQ Diaphragm Differential Pressure Controls operate from minute changes (.03" water) in the difference between two pressures.

Ranges to cover most applications (inches of water) 6" vacuum to 6" pressure, and 30" vacuum to 30" pressure. Available for various circuit arrangements.

Electrical Capacity—0.3Amp. at 115V., A.C. or 0.15 Amp., at 230V., D.C. Can be furnished in explosion-proof or weather-proof cases.

WRITE FOR BULLETIN CA-3P

THE MERCOID CORPORATION
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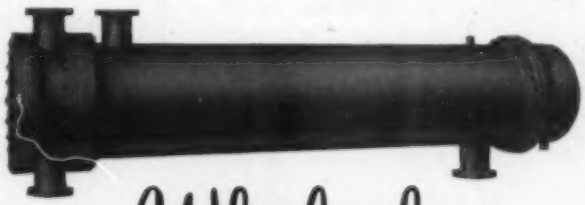
NOTE ON COMPRESSOR MAINTENANCE

Keep 'Em Cool!

The efficient operation of your compressors — in fact, their *life* — depends on the removal of waste heat from lubricating oil and water cooling systems. The Whitlock Type SG Cooler is specially designed for such service. It is small yet capable of handling relatively high heat loads, and its standardized design means low cost and prompt shipment.

The cooler is two-pass in design and properly baffled to develop high fluid velocities and subsequent high heat transfer rates, with minimum pressure drop. Its non-ferrous tube bundle, cast iron channel and steel pipe shell mean long, trouble-free equipment life even under severe operating conditions. Bulletin 122 gives you the whole story on Whitlock Lube Oil and Jacket Water Coolers. For your copy, just fill in and return the coupon today.



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WHITLOCK Designs and builds: bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers.

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FOR PIPE LINE PUMPS

SEALOL

Flexibox

MECHANICAL SEALS

SEALOL — exclusive representative in the United States and Canada for Flexibox — offers the pipe line industry a complete and tested line of mechanical seals for pipe line pumps. Flexibox Seals come to this country with over 15 years of actual oil refinery and pipe line service behind them. They afford safety and security never before obtainable with conventional stuffing boxes.

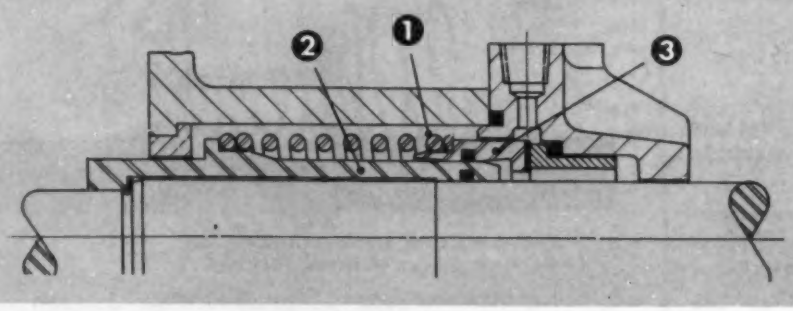
Flexibox Seals are simple and rugged — their unique spring drive reduces mechanical components to a minimum. There are no rubber sleeves or bellows — no keys, pins, slots or grooves. With the Flexibox Type RR seals (shown below) sleeves are furnished as a component of the seal assembly. No pump sleeve required. Designed especially for each installation — no measurements are required for assembly. Seals are supplied with a novel circulating arrangement which assures liquid at the seal faces at all times, removing frictional heat and reducing wear.

Many major oil refining and pipe line companies throughout England, on the Continent, and in South and Central America have standardized on Flexibox mechanical seals for their pumps. Write for Bulletin 9. Sealol Corporation, 23 Willard Avenue, Providence 5, Rhode Island. Chicago • Cleveland • Houston • Los Angeles • Philadelphia • Kansas City • Charleston (W. Va.) • San Francisco • New York • Montreal, Canada. Flexibox, Ltd., Manchester, England.

OPERATING PRINCIPLE OF FLEXIBOX SEALS

The spring ❶ engages the shaft sleeve ❷ at one end and the neck of the rotary seal ring ❸ at the other with interference fits. In operation the coils tend to "wind up", thus further increasing their grip. Consequently, the rotary seal ring ❸ is driven positively yet resiliently.

flexibox



SEALOL

THE BALANCED PRESSURE SEAL

In brief . . .

American Pipe Line Corporation of New York was granted an amended certificate of necessity permitting it to write off at fast rates 40 percent of $170 million of pipe line facilities. This replaced an earlier certificate which allowed the company only 25 percent of $158 million for the same project. The certificate covers a line to be constructed from the Houston-Beaumont area to Newark, N. J., a distance of 1425 miles. The fast writeoff was granted on the grounds that the additional capacity is desirable for defense.

•

An American-Turkish company has been formed to pipe natural gas to Istanbul, where its uses will include fuel for power stations.

•

South Carolina Natural Gas Company won the first exemption from FPC control under the Hinshaw Amendment to the Natural Gas Act. The amendment provides that any company which buys natural gas at or within a state boundary is exempted from the Natural Gas Act if all of the gas so purchased is used within that state and if rates, service and facilities are regulated by the state.

•

The Federal Power Commission was a man short after Commissioner Doty's term expired last month. Departure of Doty, a Democrat, left the commission with two Republican members, a Democrat and an Independent.

•

The U. S. Chamber of Commerce urged congressional approval of President Eisenhower's request for an $81.6 million shipbuilding authorization, including $26 million for the Maritime Administration to implement the tanker trade-in program.

•

Fuel oil use at power plants continues to lose ground to natural gas, FPC reported. April's oil consumption was 4,783,-134 barrels, down 33 percent from the same month a year ago. April gas use was more than 91 billion cubic feet, up 19 percent from a year ago. Coal consumption was 8.7 million tons, down 2.6 percent from a year ago.

•

The Texas Company may build a $2,-225,000 West Coast headquarters building in Los Angeles if City Council approves request for a zoning change.

•

New England fuel oil dealers have taken up the cudgel in earnest against the natural gas invasion. The Independent Oil Men's Association of New England called for assessments of $500 per 1 million gallons of fuel oil volume to do a selling job for oil.

Demand Up Slightly

The total demand for all oils to be supplied by the U. S. petroleum industry in 1954 will be only 2.1 percent greater than in 1953, according to the revised forecast of the Bureau of Mines. This represents a downward revision from the estimate originally made late last year.

Holding down the requirements will be the substantially lower level of exports, which are now expected to be 20.2 percent less than in 1953. Domestic consumption of all oils will be 3.3 percent larger in 1954 than in 1953, it is anticipated.

By quarters, the total demand will show rather widely varying increases over the like periods of last year. There was an actual gain of 1.5 percent in the first quarter, the report showed. For the second quarter an increase of only 0.3 percent is indicated. In the third quarter there will be an increase of 2.2 percent over last year, it is estimated. Finally, for the fourth quarter, a gain of 4.9 percent is forecast.

The 20.2 percent drop in total exports will include a decrease of about 40 percent in crude exports and a decline of 17 percent in exports of refined products, the revised forecast indicates. In the first quarter there were actual decreases of 49.1 percent in crude exports and 17.0 percent in product exports. Principal reason for the decline in crude exports is the completion of new pipe lines in Canada to supply local refineries with crude of Canadian origin.

The forecast 3.3 percent gain in domestic demand in 1954 includes an increase of 3.3 percent in gasoline demand for the year, a decline of 3.3 percent in demand for residual fuel oil, and gains of 8.0 percent for distillate fuel oil, 5.7 percent for kerosine, 49.3 percent for jet fuels, and 2.4 percent for other products in the aggregate.

Full Speed Offshore

Texas-Louisiana Continental Shelf operations, long hobbled by war and its shortages and then by the federal-state controversy and its uncertainties, are being pushed toward a dazzling tempo by a fabulous outlay of money, energy and brains.

This can be illustrated by progress made and anticipated in just three phases of the tremendous undertaking as cited last month by Ben C. Belt, vice president of production for the Houston division of Gulf Oil Corporation, before a group of oil writers at a Deepwater Press Party at Corpus Christi.

• **In Exploration:** Operations have progressed so rapidly in recent years that in all probability 10 to 14 oil companies have done seismograph work on 70 to 100 percent of land bounded on the north by the shore, on the east by the Mississippi River, on the west by the Rio Grande, and on the south by the 120-foot depth line.

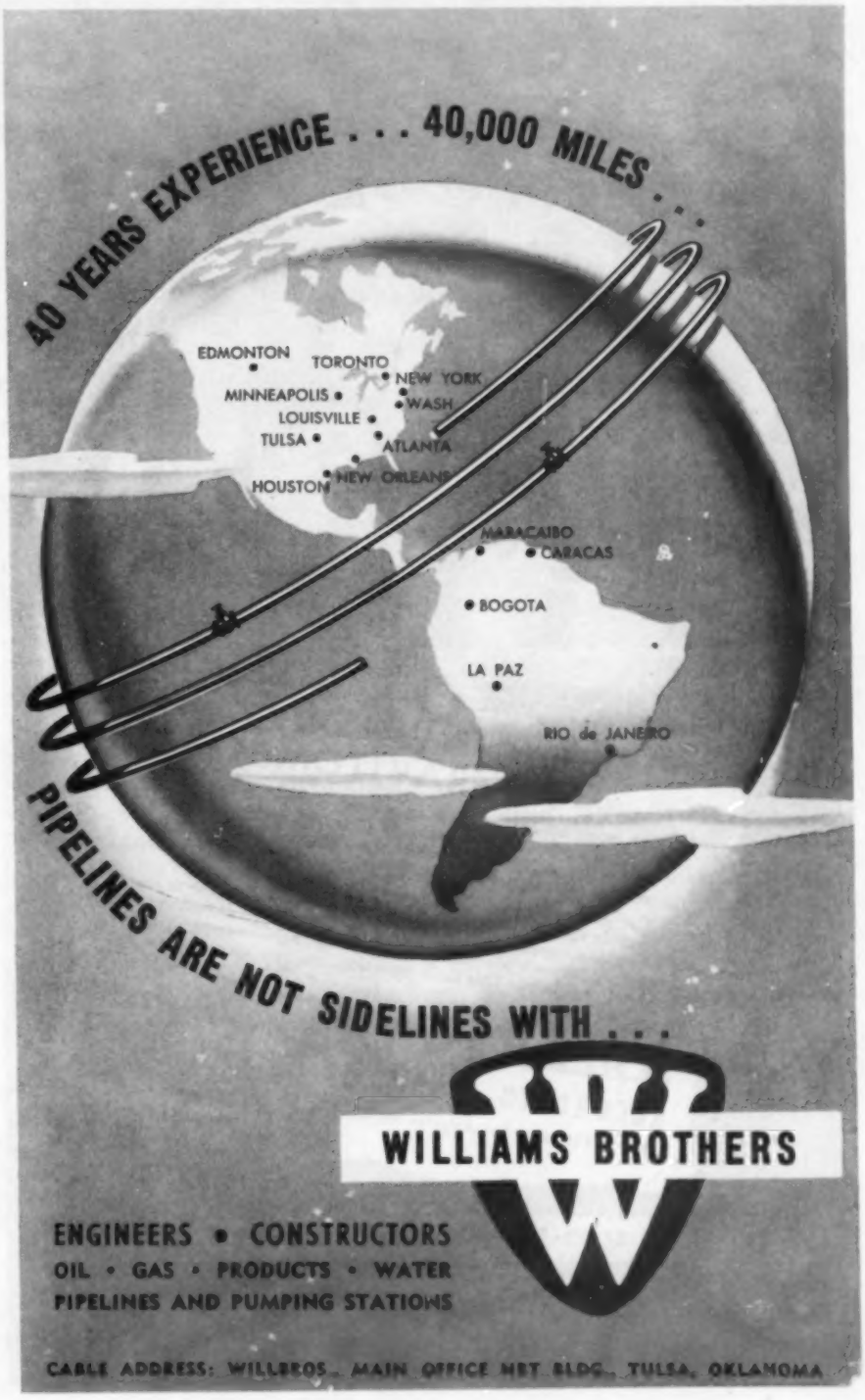
• **In Drilling Technique:** The LST which Gulf converted at a cost of about $2½ million to drill on its block off Texas will be obsolete within a very few years.

• **In Development:** The spirited campaign in the next five years could easily add from 4 to 6 billion barrels of oil to our national reserves and might add about 15 or 20 trillion cubic feet to our gas reserves. This possibility gains impressiveness when compared with the sum total of accomplishments since 1945. There are now on the Continental Shelf only 14 oil fields producing 25,000 barrels per day from 118 wells. There are 12 gas fields (most of them shut in), with four of them producing in excess of 150 million cubic feet per day.

Nevada is 29th Oil State

Nevada became the nation's 29th oil-producing state last month with the completion of Shell Oil Company's Eagle Springs Unit 1 in Nye County, 60 miles southeast of Ely.

On 24-hour test the well pumped 410 barrels daily gross with a 9 percent cut, or 373 barrels of clean oil. The well is producing from 6430-6730 feet.



Pipe Line Men

IN THE NEWS

Monty G. Martin has been appointed chief geologist for the Gas Supply department at **Texas Gas Transmission Corporation.** He has served as chief geologist for Southwest Natural Production Company for the past two years.

A graduate of the University of Oklahoma, Martin joined Carter Oil Company in 1946 as a geologist. He was employed by Texas Gas from September, 1949, to April, 1952, leaving the position of supervisor of geologists to become chief geologist with Southwest Natural.

ARCCO
ARCCO-ANUBIS dry air
GAS GRAVITOMETERS
Like many other gas transmission lines throughout the world, the Tennessee Gas Transmission Company also uses Arcco-Anubis Gravitometers for accurate recording of specific gravity on main line gas measurement.
The Arcco-Anubis Dry Air Gas Gravitometer determines and records specific gravity of gases, automatically corrected to the humidity content and temperature of the air. The difference in weight between a column of gas and an equal column of dry air is measured. This ratio represents the true specific gravity of the sample.
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3113 E. 11th St. • Los Angeles 23, Calif.
Now—DELIVERY 2 TO 3 WEEKS
SEND FOR BULLETIN No. 101R

Dr. Judson L. Anderson, geologist specializing in gas and oil research estimates, has joined **Columbia Gas System** as an assistant to **Irving K. Peck,** vice president, Houston. Dr. Anderson received a doctor of philosophy degree from Johns Hopkins University in 1928. He has had wide geologic experience in the U. S. and in foreign countries.

Dr. J. L. Anderson

•

Three changes and promotions have been made in the supervisory staff of the **Mid-Continent Pipe Line Company.**

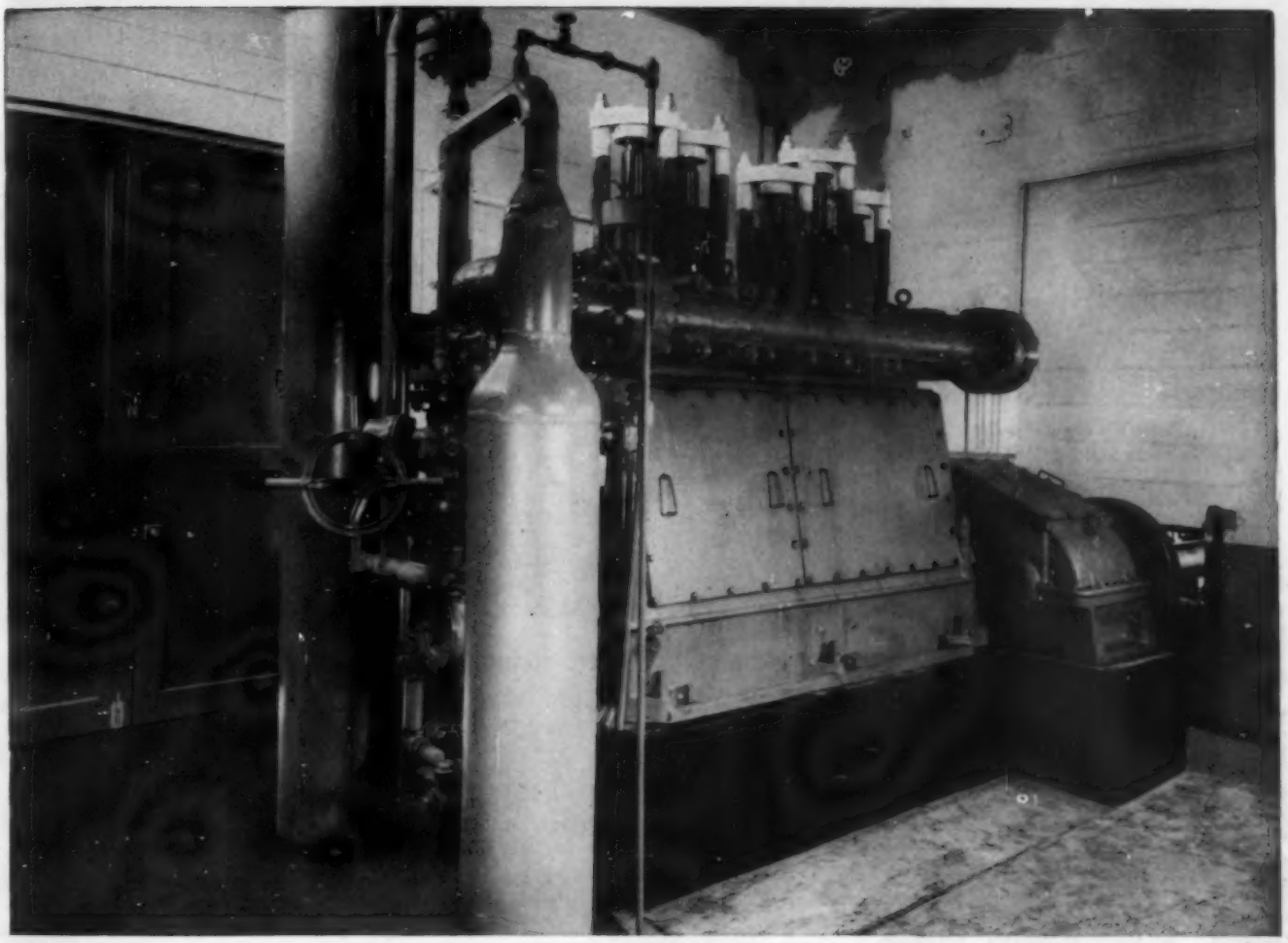
M. C. Jones, assistant general superintendent, Tulsa, will be in charge of crude oil traffic. **O. E. Bryant,** district superintendent in Wewoka, has been promoted to assistant general superintendent in charge of operations, with headquarters in Tulsa. **R. L. Cowan,** foreman of gaugers, now located in Tulsa, will succeed Bryant in Wewoka as district superintendent.

•

Richard P. Shuck has been appointed supervisor of oil movements for **The Ohio Oil Company.** Presently Pipe Line Accounting department supervisor, Shuck assumed the newly established position June 1. In this capacity, he will coordinate the movement of both crude oil and petroleum products through the company's pipe line transportation system.

Richard P. Shuck

First employed by Ohio as a messenger in 1930, he has served in the Marketing and Pipe Line departments. He was named supervisor of the Pipe Line department in 1950.



ALDRICH PUMPS Send Liquids Through Cross-Country Pipe Line

In service at the North Salt Lake Pumping Station of the Salt Lake Pipe Line Company, this Aldrich Quintuplex Inverted Direct Flow Pump and a twin unit are used to pump liquid products through an 8″ pipe line to Boise, Idaho, some 350 miles distant.

Fluids sent on their long distance journey by these Aldrich Pumps include regular and premium automotive gasolines, Diesel fuels, stove oils and alkyate. Pumps feed 375 gpm, against maximum discharge pressure of 1700 psi. Suction pressure averages 30 to 40 psi. Installed in December 1952, these pumps already have been in operation more than 2000 hours each.

This operating performance story is typical of Aldrich's record throughout the oil industry. In whatever way they're called upon to serve—whether water flooding, lean oil service, salt water disposal, crude and gathering lines, product lines, bottom hole pump service, or pumping liquid hydrocarbons—Aldrich Pumps set standards for dependable operation.

With Aldrich Pumps the user gets several marked construction advantages and benefits. For example, fluid ends are sectionalized, so that parts can be replaced quickly and at low cost. Plunger sizes are changeable, and wearing parts are interchangeable among pumps of the same stroke sizes. And ample stocks of spare parts are maintained at Mid-Continent and California locations.

Aldrich Direct Flow units are available in 3″, 5″ and 6″ stroke sizes, with 3, 5, 7, or 9 plungers . . . range from 10 to 2400 hp. Pressures are available to meet requirements (up to 15,000 psi or higher).

Write for catalogs, engineering service or a representative's call. We invite your inquiries.

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SNATCH BLOCK

★ Patented opening feature permits easy insertion of line while block is suspended.

★ Drop forged heat treated steel hooks, shackes, yokes and well rounded shells — bead encircled sheaves.

★ Heavy Duty Service for Handling and Fabricating Pipe

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Box 2496 Tulsa, Oklahoma

Something Different Happened Every Day!

Around the job site of the pipe line recently constructed by Sammy Collins in British West Africa for Socony-Vacuum Oil Company, something different was seen every day. Pictured here are a group of Gold Coast natives, residents of a Catholic girls' school and orphanage near the line.

The men are Warren L. Morris, left, Socony-Vacuum's chief inspector, and Collins. The children, like their mothers, can balance and carry bottles, pails and other such cumbersome objects on their heads with ease. The child at left center is an African albino.

Socony-Vacuum's sea-loading pipe line, believed to be the world's longest, was laid into the rough surf of the Atlantic Ocean. Collins has pipe line jobs also in India, Australia and Venezuela.

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Sydney S. Smith, manager of **Shell Oil Company's** Products Pipe Lines department, received an honorary doctor of science degree from his alma mater, Marietta College, at commencement exercises June 7. Smith will retire from Shell Aug. 1.

Sidney S. Smith

Smith, who was graduated from Marietta in 1915, is also vice president and a director of **Inland Pipe Line Company** and operations manager for **Wolverine Pipe Line Company.** He designed the portable pipe line used in all theatres by the armed services in World War II.

He served during 1952-53 as an advisor to the North Atlantic Treaty Organization in the building of a jet fuel pipe line system to supply NATO air bases in Western Europe.

•

William L. Stanton has been named manager of **Texas Gas Transmission Corporation's** Gas Supply department in Shreveport. Stanton has been superintendent of gas supply for the company and its subsidiaries since July 1, 1949. As manager of the department, he will be responsible for gas purchase contracts, gas reserves and gas proration for the 3000-mile Texas gas pipe line system.

William L. Stanton

•

Joe M. Vernon, formerly of **Cities Service's** Industrial Relations division, has been transferred to **Cities Service Pipe Line Company** to do research on crude oil measurements. He replaces **Fred Daneke,** who is transferring to **Badger Pipe Line Company.**

Lawrence M. Jack has been appointed assistant superintendent of the Right-of-Way department of **Service Pipe Line Company** to succeed **A. J. Wisdom,** who retired in May. Jack joined Service Pipe Line Company in 1946.

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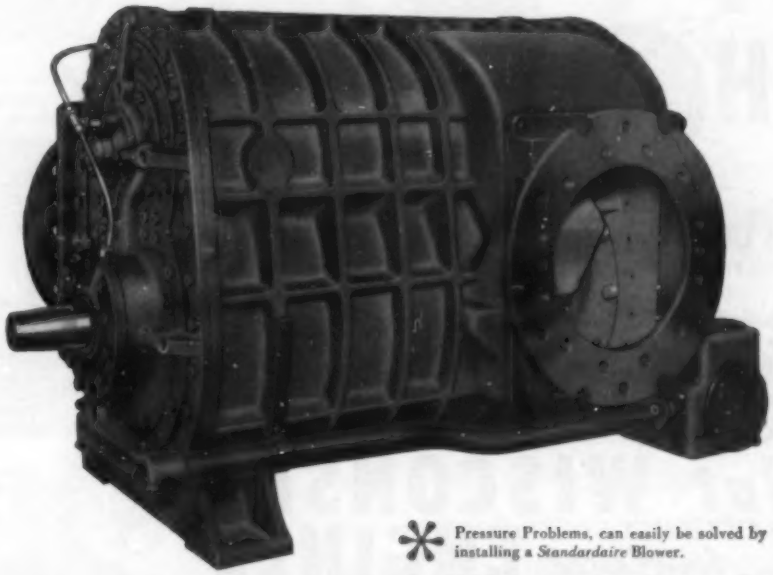

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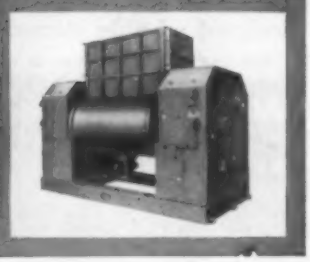


What's Happening

AMONG SERVICE AND SUPPLY MEN

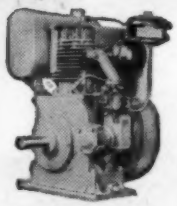
Air Reduction Sales Head Retires; Successor Named

H. R. Salisbury, president of Air Reduction Sales Company, has retired. He continues as a director of Airco's foreign subsidiaries, Air Reduction Canada Limited and Cuban Air Products Corporation.

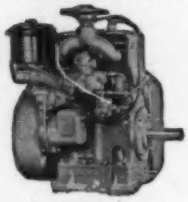
J. H. Humberstone, president of Ohio Chemical and Surgical Equipment division of Airco, will succeed Salisbury. Humberstone also is vice president of Air Reduction Company, Incorporated.

Salisbury has been with Airco since 1926. Humberstone formerly was associated with General Electric Company, joining Air Reduction in 1948.

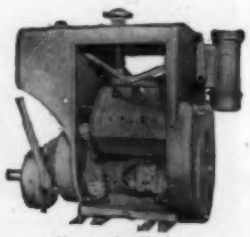
But WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINES *Deliver Dependability*



4-cycle single cylinder models, 3 to 9 hp.



2-cylinder models 7 to 15 hp.



V-type 4-cylinder 15 to 36 hp.

Down in the Midkiff field, Upton County, Texas, where the El Paso Natural Gas Company is engaged in one of the largest expansion programs in pipe line history, Wisconsin Air-Cooled Engines are in there pitching, and doing a good job.

The picture shows a Wisconsin Model VF4D operating the pumps and agitators on a pipe line tar pot. And this job, like many other power applications in the oil field, calls for Dependable Power.

Because of Wisconsin heavy-duty engineered design and construction, these rugged engines keep slugging away as long as there is work to be done. They have the built-in *lugging power* that enables them to *hang on* when sudden shock loads slow down the engine speed, and pick up again without loss of efficiency.

For oil field service, 2-cylinder and 4-cylinder engines are equipped with Stellite Exhaust Valves and Inserts, whether specified or not — and all 4-cylinder engines are supplied with a specially designed oil filter element.

You can't do better than to specify Wisconsin Engine Power for your equipment.

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OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

A 7937-½ I-O

Lewis Named to Sales Post With Reilly Tar and Chemical

A. David Lewis, Jr. has been appointed a creosote oil sales representative by Reilly Tar and Chemical Corporation. Lewis was formerly associated with the Research department of Tennessee Products and Chemical Corporation. Before joining the Reilly Tar and Chemical Corporation laboratory at Chattanooga in 1954, Lewis was engaged in the construction business.

A. David Lewis, Jr.

Lewis will cover the southeastern territory covering Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi and Louisiana east of the Mississippi River.

Gar Wood Industries Appoints Schurhammer District Manager

R. L. Schurhammer has been appointed district manager of Gar Wood Industries, Inc., Wayne, Mich. Since joining Gar Wood in 1949, Schurhammer has been a tractor equipment service representative. Formerly he was a heavy equipment operator for Peter Kiewit Sons's Co., Omaha.

In his new position, Schurhammer will work with the following Gar Wood, Allis-Chalmers dealers: Dukehart-Hughes Tractor & Equipment Co., Inc., Cedar Rapids and Des Moines, Iowa; Borchert-Ingersoll, Inc., St. Paul and Duluth, Minn.; Sweeney Bros. Tractor Co., Fargo, Williston and Riverdale, N. D.; Mountain Tractor Co., Missoula, Mont.; Richland Machinery Co., Sidney, Mont.; Seitz Machinery Co., Inc., Billings and Great Falls, Mont.; Fehrs Tractor & Equipment Co., Omaha, Neb.; Sioux Road Equipment, Inc., Sioux Falls, S. D.; Studer Tractor & Equipment Co., Casper, Wyo.; Vulcan Machinery & Equipment, Ltd., Winnipeg, Manitoba and Western Tractor & Equipment Co., Ltd., Regina and Saskatoon, Saskatchewan.

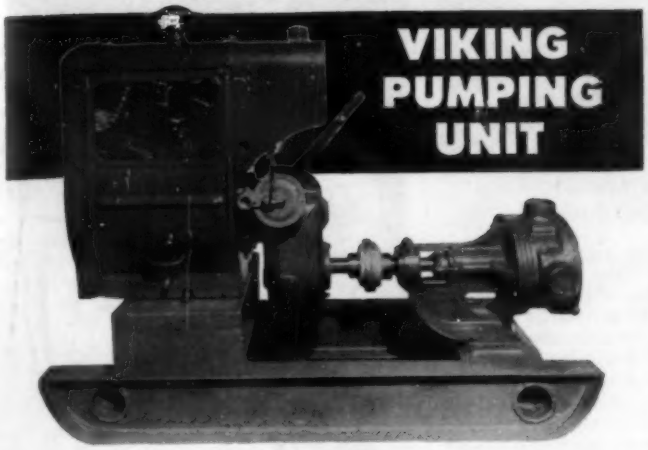
Bendix Radio Names Caplan Manager of Commercial Engineering

Norman Caplan has been named manager of commercial engineering at the Bendix Radio Communications division of the Bendix Aviation Corporation. He replaces Douglas M. Heller, who has been appointed director of engineering at the missile plant of the Bendix Aviation Corporation's Products division in Mishawaka, Ind.

Heller, a native of Dover, England, and a graduate of the Royal College of Science, was employed by Bendix Radio for the last seven years and was responsible for the development of several of the firm's most important communication and navigation devices.

Caplan was formerly chief engineer, communications and navigation engineer-

Another Efficient



Viking pumps are giving top performance wherever used in the pipe-line industry. The above installation is serving a major pipeline company and consists of: a Viking Model L-124, Size 2" Standard fitted heavy duty rotary pump mounted on welded steel skids and direct connected through 7 F Falk coupling to a 2 cylinder Air Cooled Power Unit.

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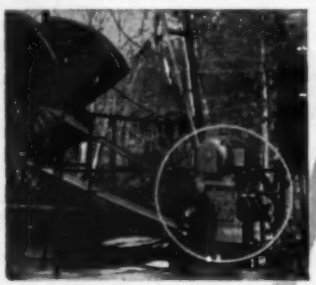

Typical oil field installation on single reduction pumping unit pumping 10, 13, 16 and 19 SPM.

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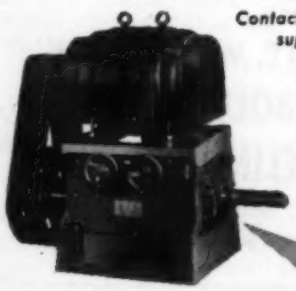

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And numerous other specialized oil field pumping jobs.

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ing. In his new position he will be responsible for the design and development of commercial products in the aviation, automobile and mobile radio fields.

J. H. Taylor, veteran of 14 years of engineering service with Bendix Radio, will succeed the position vacated by Caplan.

Frazier Named Field Manager Of American Air Filter Sales

John W. Frazier has been named field manager of air filter sales by American Air Filter Company. He served as general sales manager of Trion, Inc. for the past seven years and formerly was supervisor of dealer relations with Equitable Gas Company in Pittsburgh.

John W. Frazier

Frazier will have headquarters in Pittsburgh and will work with the various district sales offices of the company over the nation. The assignment of a field manager is a new position with the company.

Leece Elected President Of Gardner-Denver Company

Gifford V. Leece has been elected president of Gardner-Denver Company and Benjamin C. Essig has been elected executive vice president. Leece has been vice president and sales manager since 1947, having joined the company in 1922. Essig, who now becomes executives vice president of the firm, joined Gardner-Denver in 1923.

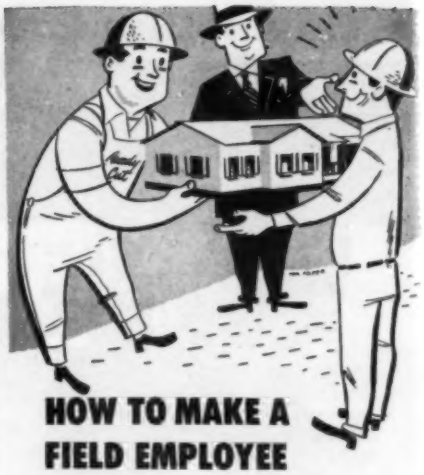
Southwest Industries Organizes As New Company in Houston

The organization of a new Texas company, Southwest Industries, Inc., has recently been announced. Formerly known as Southwest Steel Plate Division of Southwest Steel Products, the company will operate as an independent company. The new name was adopted to avoid confusion with Southwest Steel Products with which it was formerly associated. Southwest Steel Products has been integrated recently with Armco Steel Corporation.

Southwest Industries, Inc. manufactures a complete line of packaged gas compressor plants using Cooper-Bessemer compressors. Office and plant location will be maintained in Houston. Jay L. Cannon, Jr. is president and other officers are Guy W. Cheesman, Jr., vice president; Calvin W. Boehmer, secretary, and Richard M. Firth, treasurer. On the board of directors are Russell L. Jolley, chairman, David W. Hallam, J. T. Curling, and officers of the company.

Ladish Company Acquires Assets Of Tri-Clover Machine Company

Ladish Company of Cudahy, Wis., has acquired the assets of Tri-Clover Machine Company of Kenosha, Wis., by purchase of its capital stock. Tri-Clover Machine Company, with plants in Kenosha and Cudahy, will operate as a division of Ladish Company.



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Foxboro Company Announces Election of Vice President

W. W. Frymoyer has been elected a vice president of The Foxboro Company. Joining the firm in 1926, Frymoyer served as director of research and in 1939 was appointed general superintendent. Since 1951 he has been factory manager and will continue in this capacity, supervising instrument manufacturing activities of the company.

W. W. Frymoyer

Formerly Frymoyer was connected with the National Bureau of Standards, Washington, D. C., and received his degree in mechanical engineering at Massachusetts Institute of Technology.

Oil Well Supply Names Jacoby Refinery-Pine Line Sales Manager

Michael Jacoby, a veteran of 37 years with U. S. Steel's Oil Well Supply division, has been named manager, refinery and pipe lines sales for its California area.

Jacoby comes to Los Angeles from Tulsa, Okla., where he has served as district engineer, refinery and pipe line sales since 1952.

Starting with "Oilwell" in its general offices at Pittsburgh in 1917, Jacoby has been engaged in sales work for 23 years. He transferred to the Sales department at the division's Wilson-Snyder Works, Braddock, Penn. in 1931. In 1936 he moved to the Chicago sales office as sales engineer specializing in sale of "Oilwell" pumps. Jacoby returned to Wilson-Snyder Works as a sales representative in 1945, remaining there until he transferred to the Tulsa post.

RCA Engineering Division Announces Appointments

Appointments of E. J. Hart, as microwave equipment sales manager; D. C. Bright, as administrator of communications national accounts; and H. G. Boyle, as communications field sales manager, have been announced by the Engineering Products division of the Radio Corporation of America.

At the same time, RCA announced the appointment of five district sales managers for communications equipment, both microwave and mobile two-way radios. They are Bernard Gest, central region; K. R. McHenry, southwestern region; D. B. McKey, southern region; D. L. Pearlston, eastern region; and D. O. Reinert, northwestern region. Continuing as district sales managers in other regions are S. J. Combs, western region; F. C. Gusler, west central region; and C. K. Sulger, east central region.

Allis-Chalmers Announces New District Office Managers

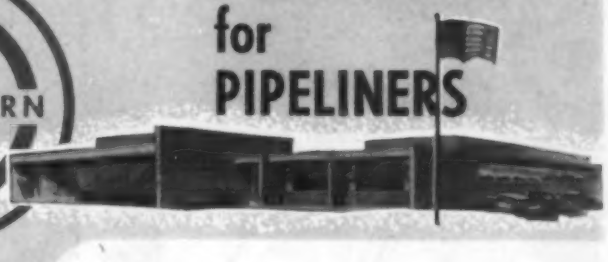
Four new district office managers have been appointed in Allis-Chalmers General Machinery division sales organization. They are R. H. Porterfield, Hartford; Aubrey Phillips, Milwaukee; D. R. Boise, Houston, and J. C. Lovelace, Amarillo.

Caterpillar Opens New Plant at York, Penn.

Improved parts service to its eastern and export customers and expansion of its manufacturing facilities have been achieved recently by Caterpillar Tractor Company with the opening of its new plant at York, Penn. The dual-purpose facility at York manufactures certain replacement parts for the company's line of track-type tractors and also serves as a regional storage and shipping center for the company's entire parts line.

MIDWESTERN

HEADQUARTERS for PIPELINERS



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Petroleum engineers specify these starters for Division 2 semi-hazardous locations because they assure substantial savings in installation and operation.

Construction advantages include: drip-proof roof . . . tank-cover and front cubicle doors . . . oil switch which opens 220-volt control transformer before upper door can be opened to operate main line disconnects . . . hermetically sealed control circuit contacts . . . main contactor with alloy contacts oil-immersed in rear tank. On voltage dips, push button circuit maintained up to 2 seconds by simple 3-wire circuit, permits opening of "stop" circuit without delay.

EC&M 2200-5000 volt Starters are also available in Division 1 style for Class 1, Group D Hazardous Locations. For interrupting capacities above 50,000 KVA, EC&M VALIMITOR (volt-ampere-limitor) Starters are furnished in both Division 1 and Division 2 construction.

Write for 16-page Booklet 1062 for complete details.

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Binkerd Named District Manager Of American Locomotive Company

Robert H. Binkerd has been appointed district manager of American Locomotive Company's new Pittsburgh sales office.

R. H. Binkerd

A graduate of Harvard University, Binkerd joined Alco in 1943 as a buyer in the company's New York office. In 1947 he was transferred to the Purchasing department of the Dunkirk, N. Y., plant and later became plant purchasing agent. He became district sales manager in Dunkirk in 1949.

Grant Named to New Position By Butler Manufacturing Co.

Charles E. Grant has been appointed assistant manager of the Oil Equipment division of Butler Manufacturing Company, Kansas City, Mo. A graduate of Penn State College, Grant was previously with the Diamond Alkali Company, Cleveland.

C. E. Grant

He formerly was a sales engineer with Bastian-Blessing Company in Chicago. During World War II he served as an officer in Army Corps of Engineers. He will assist in the supervision of the sale of Butler's oil equipment, which includes truck tanks, bolted tanks, LPG equipment, and welded tanks.

A. O. Smith Corporation Appoints Three to Sales Territories

Owen Ford, James McKinney and George Tweed have been assigned sales engineer territories by the Welding Products division of the A. O. Smith Corp.

Ford will be located in Birmingham, Ala., from where he will cover Tennessee, Mississippi, Alabama, Georgia and Florida. He formerly was with the A. O. Smith LPG division at Houston.

McKinney, a Californian, will headquarter in Los Angeles and cover the southern portion of the state. Tweed, who will be in Chicago, is to cover northern Indiana and Gary. He succeeds Thomas Scannell who left the company to join *Time* magazine.

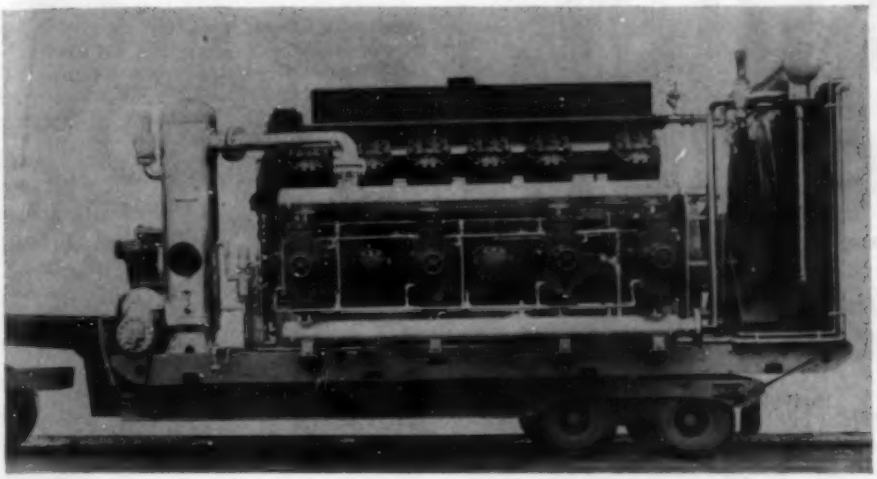
U. S. Atomic Scientist Heads Engineering at Rockwell Plant

Terrence H. M. Taylor, former research scientist with the U. S. Atomic Energy Commission, has been named chief engineer of Rockwell Manufacturing Company's Nordstrom Valve Division plant at Oakland, Calif.

A native of British Columbia, Taylor received a B.S. degree in chemical technology from the University of California in 1942 and an M.S. degree in mechanical engineering the following year. He has also completed course work and preliminary examinations for his Ph.D. in mechanical and chemical engineering.

What's New in Equipment

for the Pipe Line Industry



A concrete slab and minor adjustments at location are all that's needed to start operating this factory assembled . . .

Packaged Compressor Plant

A new 660-horsepower packaged compressor plant, the largest ever offered as a complete package, has been announced by The J. B. Beaird Company, Inc.

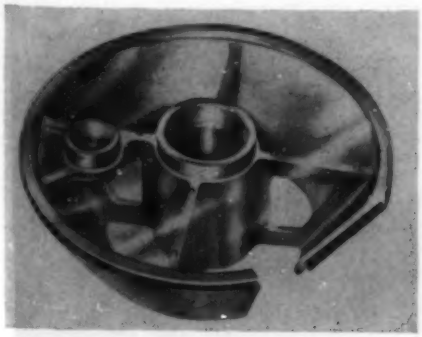
Built around the Ingersoll-Rand 12SVG gas-engine-driven compressor, the new packaged plant is designed for single or multiple unit installation on gas pipe lines, gathering lines and gas lift systems. By using these 660-horsepower plants in banks, it is possible to install a compressor station with thousands of horsepower at the low cost per horsepower typical of packaged compressor plants.

The entire unit is assembled on an integral fabricated steel base. The ruggedly constructed base eliminates the necessity for an expensive foundation at the operating site. No more than a concrete slab is required. Installation time and expense are reduced because of complete assembly in the factory as well as centralized purchasing, engineering and testing.

In spite of its large capacity, the 12SVG packaged compressor plant may be transported on heavy oil field trailers directly to location. Like other Beaird-Ingersoll-Rand packaged compressor plants, the new model includes all necessary auxiliary equipment and controls.

Literature on the 12SVG and other standard size packaged compressor plants from 110-horsepower to 660-horsepower is available from the manufacturer now. Just

For more data, **circle No. E1** on Readers' Service Card, last page this issue.



Vapor Recovery Unit

A new vapor recovery unit for preventing loss of vapors from volatile liquids during loading of tank cars and trucks is announced by Vernon Tool Company, Ltd. Known as the Greenwood vapor recovery unit, it can be connected to existing loading rack standpipe or hose units. The unit consists of a conical shape, lightweight aluminum housing, a Hykar rubber sealing ring, a transparent plexiglass cover and connection for the vapor recovery hose. When attached to the fill pipe and placed in the loading dome, the Hykar ring provides a positive seal, thus preventing loss of vapor. A snap cover permits observation when filling.

(This item supplements Vernon Tool Company data on pages 4966-4967 of the Composite Catalog, 20th Edition.)

For more data, **circle No. E2** on Readers' Service Card, last page this issue.

Heliweld Holder

A lightweight, water-cooled Heliweld holder has been produced by Air Reduction Magnolia Company for welding thin gauges of aluminum, stainless steel, copper base alloys, magnesium and killed steel. It is specifically designed for manual Heliwelding in the aircraft, home appliance and petroleum industries.

Known as the Airco H12A, this new fabrication tool's insulation material is constructed of a tough plastic to withstand rough treatment. Completely water cooled for safe operation, the Airco H12A provides protection from overheating in confined working areas. Other features include interchangeable electrode caps—2-inch, 3-inch and 7-inch lengths; an assortment of ceramic nozzles designed to prevent arc-shorting in tight spots; a ruggedly constructed 12-foot long water-cooled cable assembly; four sizes of collets to accommodate .020-inch, .040-inch, 1/16-inch and 3/32-inch diameter tungsten electrodes; and gas tight sealing rings at the vital points to insure low operating costs.

The Airco H12A holder is rated at 125 amperes and can be operated on AC or DC power. The holder measures 7½ inches in length and weighs only four ounces.

(This item supplements Air Reduction Magnolia Company data on page 159 of the Composite Catalog, 20th Edition.)

For more data, **circle No. E3** on Readers' Service Card, last page this issue.

Blinds and Spacer Rings

"Visi-Tab" is the trade name of the Engineering Corporation of America for new lightweight blinds and spacer rings as an improvement over customary "spectacle" blinds in process pipe lines—in applications for oil refineries, petrochemical plants, distributing plans and pipe line testing.

Because "Visi-Tabs" extend beyond the pipe flanges, the unit can be identified as a blind that is completely sealing a flow shutoff or a spacer ring providing an open flow. The blinds have blank discs at the end of the tab while spacer rings have an open ring at the end.

These blinds and spacer rings are available in sizes for all standard pipe lines, for raised face, ring type joints and tongue and groove flanges with full range of ASA service pressure and temperature ratings including 150, 300, 400, 600, 900, 1500 and 2500 pounds per square inch gauge. They can be furnished in carbon steel,

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carbon moly, chrome moly, stainless steel monel, alloy faced carbon steel and other special alloys.

"Visi-Tabs" require small space, important where pipe lines are close together in parallel, and result in savings in inventory and investment costs as a spacer ring may be used in another pipe line while the corresponding blind is already in service.

For more data, **circle No. E4** on Readers' Service Card, last page this issue.

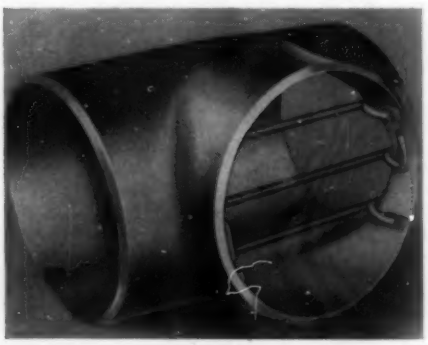
Hook-on Volt-Ammeter

A new hook-on volt-ammeter believed to be the first with automatic scale changing has been announced by the General Electric Company's Meter and Instrument department. Designated the AK-5, the pocket-size unit is designed to measure current and voltage quickly and accurately. Its automatic scale changing feature eliminates the possibility of reading the wrong scale for the application. An aid in balancing circuits, tracing faults and grounds, estimating distribution circuits and diagnosing operating troubles, the volt-ammeter is an accessory for engineers, contractors, maintenance and service men and others.

The five-ampere range permits load checks on fractional horsepower as well as low energy control circuits. The instrument also measures AC voltage in three ranges (150/300/750) without auxiliary equipment, provides accuracy up to three percent of full scale and withstands a voltage breakdown test of 4000 volts AC.

(This item supplements General Electric Company's Electronics Division data on pages 1846-1847 of the Composite Catalog, 20th Edition.)

For more data, **circle No. E5** on Readers' Service Card, last page this issue.



Bar Equipped Tees

To aid pipeliners in solving the problem of wandering pigs, Tube Turns has made

available a Tube-Turn tee equipped with alignment bars. The bars are made from heavy wall pipe and shaped to provide flexibility. They follow the elastic movement of the tee as pressure is applied and there is no tendency to break attachment welds.

The tee equipped with bars can be supplied for pipe line applications on reasonable notice. Tube Turns also furnishes the elbows, reducers and other fittings required in the construction of pig launching stations and traps.

For more data, circle No. E6 on Readers' Service Card, last page this issue.

Pipe Saw

A new type of weld preparation which eliminates the use of a "transition piece" allowing one weld to take the place of two and permitting greater distance between welds has been used on the 860-mile Gulf Interstate Gas Company line from Louisiana to West Virginia. Field machining of the one-half-inch wall pipe with the new inside beveling attachment for the Wachs National Pipe Saw makes this single type weld possible. One-half-inch wall pipe was double or triple joint welded into lengths required for crossings. Test plugs were welded on the ends and an eight-hour hydrostatic test run on every crossing section. The Wachs National Pipe Saw with standard saw and external bevel cutter were used to cut the test plugs off the heavy wall pipe at completion of the hydrostatic tests. Then the bevel attachment was placed on the basic Wachs saw unit and an internal bevel machined to reduce the one-half-inch pipe down to proper welding thickness for three-eighths-inch wall pipe. This results in a "machine shop" bevel (inside and outside) ready for welding with no change in the physical properties of the pipe.

For more data, circle No. E7 on Readers' Service Card, last page this issue.

Compressor

Pipe line and heavy construction contractors can take advantage of the new Le Roi 600 CTM (compressor tractor mounted). The Le Roi 600 CTM with side booms and twin wagon drill air feed assemblies of the Le Roi-Cleveland SB30 or PL30 class can convert retired tractors into fast moving integral drilling units. This 600 cfm compressor can readily be mounted on two leading makes of crawler tractors, the International Harvester TD 24 and Caterpillar D B. By mounting the 600 CTM on a "tractionless" tractor, a newer crawler will be relieved of the expensive and slow job of towing a heavier, harder-to-handle four-wheel portable compressor.

Standard equipment includes an independent clutch to disengage compressor from power take-off shaft, deep crank case for operation at 30° angle, complete compressor controls including slow down of engine, heavy undercarriage and intercooler guards, air receivers and heavy duty oil bath air cleaners. The 600 CTM is directly connected to rear power take-off shaft of tractor and lined up to the same close tolerances as engine and compressor on a four wheel unit.

(This item supplements Le Roi Company data on pages 2825-2830 of the Composite Catalog, 20th Edition.)

For more data circle No. E8 on Readers' Service Card, last page this issue.

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Special Orders:

BURGESS-MANNING Exhaust and Intake

Snubbers installed for Tennessee

Gas Transmission Company

. . . engineered for this service.
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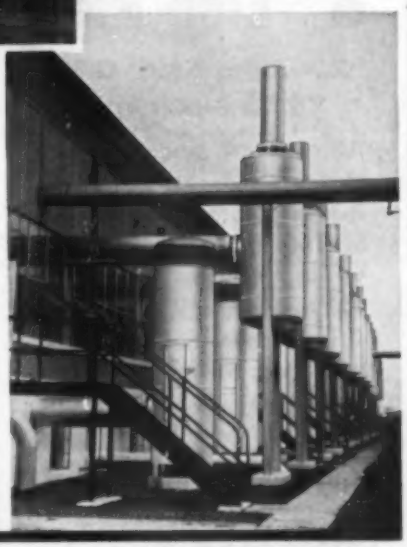
OVER 100 SNUBBERS

Below: Exhaust snubbers and combination air filter snubbers engineered and built for four 1,600 h.p. and eight 2,000 h.p. gas engines at Station #1, Agua Dulce, Texas.

Above: Seven exhaust snubbers and seven combination air filter snubbers designed to meet the silencing requirements of seven 2,000 h.p. gas engines at Station #9, Bloomington, Texas.



Proper silencing is one of the keynotes of efficiency. That is the reason Tennessee Gas Transmission Company, operator of one of the major trunk line systems in the country, consulted Burgess-Manning Sound Engineers on their silencing requirements. Over one hundred snubbers were engineered and constructed by Burgess-Manning to eliminate the intake and exhaust noises at compressor stations along the Tennessee line.

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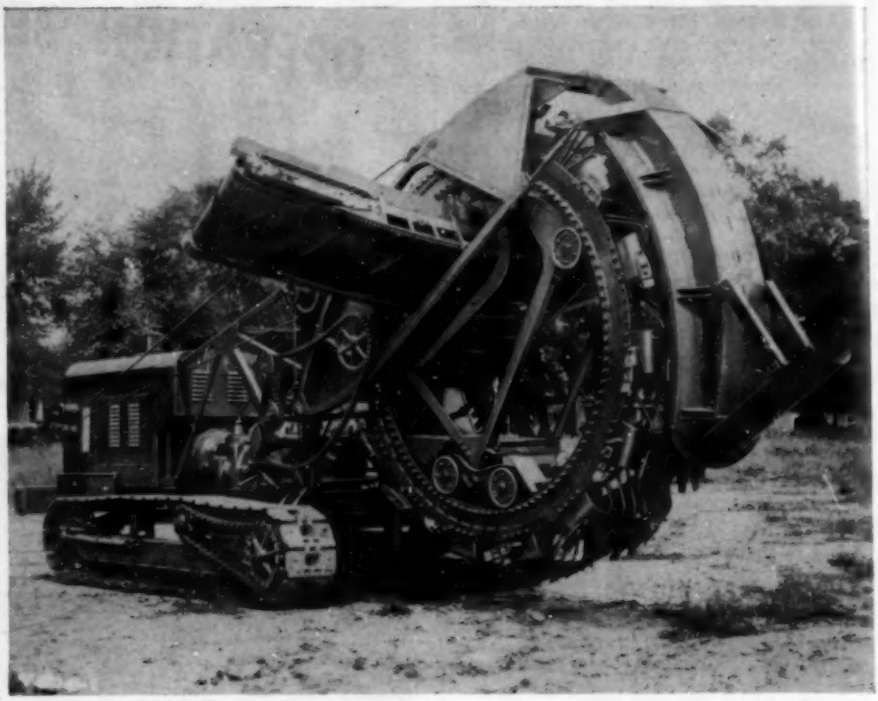

Pipe Line Ditcher

A new pipe line and utility ditcher, the Buckeye model 315, has been announced by Gar Wood Industries, Inc., Findlay Division. The Buckeye 315 is a heavy-duty, wheel-type ditcher designed for digging ditches for cross-country pipe lines for oil and gas. It is designed to dig to a maximum depth of six feet with widths of cut varying from 24 inches to 40 inches in steps of 2 inches. The machine has eight digging speeds forward, from 1.37 to 20.49 feet a minute. Independent wheel and crawler speeds make the machine flexible since maximum or minimum speed of either is available with maximum or minimum speed of the other.

A heavy duty diesel engine, 76 horsepower at 1600 revolutions per minute, powers the Buckeye 315; a gas engine, 80 hp at 1600 rpm is optional. Two types of clutches are available, either Twin Disc fluid coupling in conjunction with overcenter type friction clutch or heavy duty Twin Disc single plate toggle type clutch. Transmissions are fully enclosed and sealed against dirt. All gears are precision cut and run in oil or mesh with gears running in oil. All shafts turn on anti-friction bearings. The heavy duty digging wheel comes equipped with 15 standard buckets bolted on one piece digging rims with variable bucket spacing. Rims are drilled so that 8, 10, 12 or 15 buckets can be used. Soil can be deposited on either side of the ditch by the shiftable conveyor. There are six conveyor speeds from 225 to 764 feet a minute.

For more data, circle No. E9 on Readers' Service Card, last page this issue.

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New Equipment Literature

Pipe Fittings Handbook

A 304-page combination catalog and pipe line design handbook containing detailed dimensions, weights and specifications for selecting proper fittings for any pipe line application plus many pages of piping design data, latest code provisions and standards is now being issued by Ladish Company.

This durably bound book should prove a valuable reference on forged and seamless welding pipe fittings, flanges and forged weldless rolled rings. A complete section is devoted to each of these items. Of particular interest to those in charge of piping layouts and design is a 56-page section of tabulation of precalculated values derived from frequently used formulae for direct application to piping problems effecting their solution with minimum computations. In addition to data on dimensional tolerances, friction loss and material specifications, this section contains tables on allowable stress and P/S values, maximum working pressures, flange pressure-temperature ratings, properties of pipe, and flow through orifices and nozzles.

To get a copy, **circle No. E10** on Readers' Service Card, last page this issue.

Engine Bulletin

"Air For Your Engine" is the title of a new bulletin recently published by Cummins Engine Company in the interest of better diesel engine maintenance. This informative booklet illustrates the effects of dirt and improper air temperature. In addition to pointing out these hazards, it further describes what can be done about correcting them. Also included in this booklet is a convenient air cleaner maintenance check-off sheet.

To get a copy, **circle No. E11** on Readers' Service Card, last page this issue.

Valve Bulletin

A comprehensive, completely illustrated four-page circular describing Iron Body Bronze Mounted Grooved End Valves for grooved end couplings has just been published by The Lunkenheimer Company. The bulletin describes the Lunkenheimer grooved end valves, available in 2½ to 8-inch sizes in standard 200-pound W.O.G. gate valve patterns and in a 2-inch size 225-pound W.O.G. "King-clip" pattern. Also included are dimensions and price lists.

To get a copy, **circle No. E12** on Readers' Service Card, last page this issue.

Hose and Belt Brochure

A new brochure designed to aid the oil industry in choosing the proper types of hose and belts for specific operations has been issued by the Goodyear Tire & Rubber Company. New applications of Goodyear hose are fully cataloged according to specific duties, special features, available sizes and actual construction designs. The brochure includes information on flat belting, V-belting and sheet packing.

To get a copy, **circle No. E13** on Readers' Service Card, last page this issue.

Diesel Engines

Lister stationary diesel engines, five models of 9 to 54 bhp. with one to six cylinders are described in a new eight-page illustrated bulletin by The National Supply Company. Design features, specifications and dimensional diagrams are included.

To get a copy, **circle No. E14** on Readers' Service Card, last page this issue.

See Composite and Refinery Catalogs, or Write for Specifications Folder

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Nozzle sizes from ¼" to 24"

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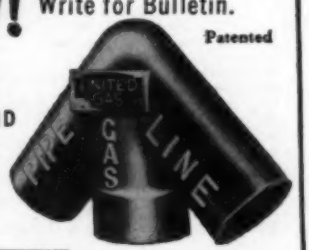

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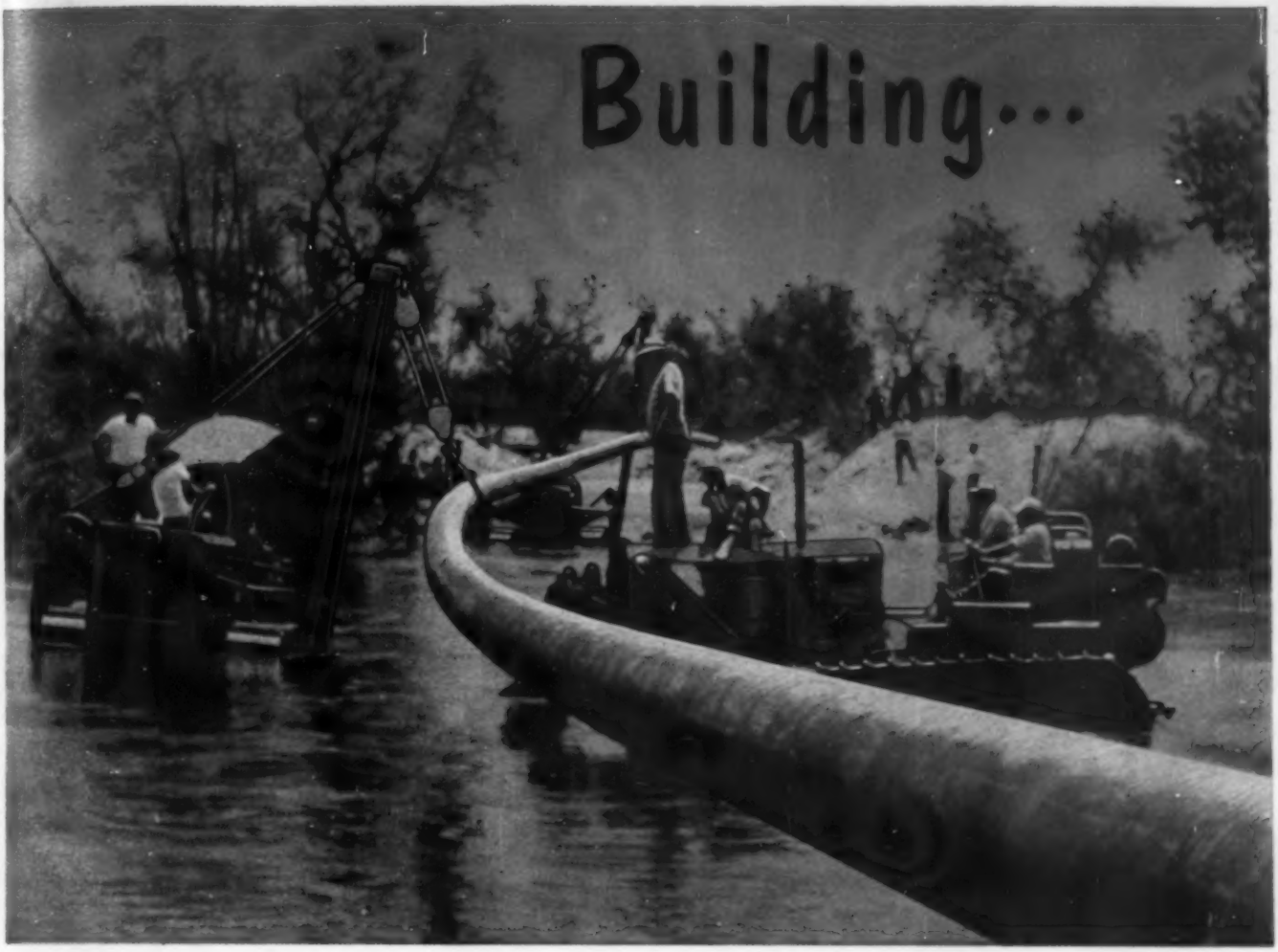
HOW DO YOU LIKE IT? **We'd like to have your opinion on this, the first issue of PIPE LINE INDUSTRY. This is YOUR MAGAZINE, written and edited to help you with your job. Your suggestions and criticisms are invited.**



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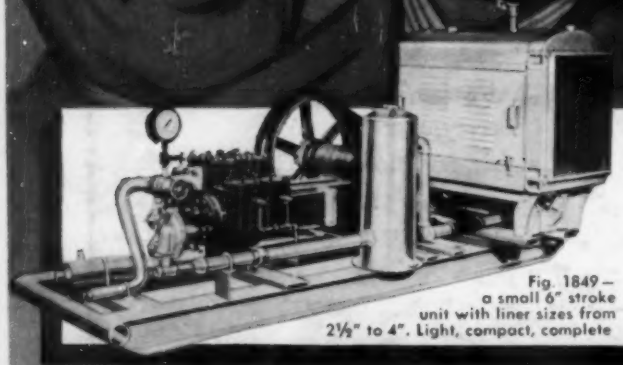

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